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October 19, 1922

Engineering News-Record

Lost Time in Construction—3
Rain and Mud Delays

Design of Sewage Dosage Tanks for Trickling Filters
E. B. Besselievre

Water-Supply for Panama Canal Ample for 30 Years
J. K. Baxter

Design Features of the Steel and Concrete Ohio Stadium
Clyde T. Morris

Ohio State University's Huge New Double Deck Stadium
When About Half Completed

General Motors Trucks

Part of the Fleet of GMC Trucks Operated by the Murray Construction Company, Knoxville, Tenn.

Have Been Steady Users of GMC Trucks for Last Nine Years

Starting with the purchase of four GMC trucks in 1913 the Murray Construction Company of Knoxville, Tenn., has added from one to four new GMC's each year and this year have purchased 14 new GMC units.

In this nine-year period, other makes of trucks have been tried, but the Murray Company has eliminated these and is standardizing on GMC trucks.

"It goes without saying that we are absolutely satisfied with the GMC truck," says Fred M. Connor, president of the company. During the period from 1913 to the present time we have tried several other makes of trucks, but after using them we have come to the conclusion that we get the best service from the GMC."

GMC Trucks Wear Longer

Every part that goes into the building of GMC trucks is oversize. GMC engineers have increased the strength of the various units over that common to other trucks of like capacity to insure against the extra severe strains that a motor truck has put upon it at different times.

By doing this long life has been built into these trucks. Moreover the design of GMC trucks has been refined to the point where there is not a single wearing part in the entire chassis which cannot be replaced. Every point of actual wear is fitted with a bushing or bearing which can be quickly and easily replaced for a reasonable cost.

Additional safeguards to continuous operation and to added years of usefulness such as radius rods, magneto ignition, conduit wiring, oversized brake drums and interchangeable brake rods are further guarantees of a longer life for GMC trucks than is common to the average motor truck. In fact there is no way in which the life of a GMC truck can be estimated. With a reasonable amount of care it should last indefinitely.

Quality Comes First

Such painstaking care in the design and manufacture of GMC trucks has resulted from a determination that quality should be the first consideration in their building. Not only are the finest materials used in their construction but these materials are fabricated to extremely fine limits of accuracy. Special machinery, designed for the manufacture of GMC trucks parts exclusively is employed in many of the operations to insure the high degree of perfection that GMC builders maintain in every truck produced by them.

Continual inspection in every process of the manufacture of these trucks starting with the rough stock and continuing after each individual operation of manufacture and assembly is a perpetual check upon the workmanship to insure that it meets the GMC standard of excellence.

And these quality trucks sell at prices that are remarkable in consideration of the value which they offer.

GMC chassis list at the factory as follows: One ton, $1,295; two-ton, $2,375; three and one-half ton, $3,600; five-ton, $3,950; tax to be added.

GENERAL MOTORS TRUCK COMPANY

Division of General Motors Corporation

PONTIAC, MICHIGAN

Dealers and Service in Most Communities

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—James H. McGraw, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. Mehren, Editor

Volume 89 — NEW YORK, OCTOBER 19, 1922 — Number 16

A Good Technical Meeting

REPORTS from the San Francisco meeting of the American Society of Civil Engineers indicate a repetition of the success of the one at Dayton last spring. Evidently these quarterly sectional meetings have taken hold. They afford opportunity for the members in different sections of the country to get together under the auspices of the society itself, with the society's general officers and with a certain number of members from outlying districts—all of which have attractions superior to a local meeting which is frankly local and draws only on local attendance. Then, too, at both Dayton and San Francisco the technical sessions were centered around a single subject, with accompanying increase in interest over the scattered subject matter typified by the rather dull technical sessions of Portsmouth last June. Careful attention to location and subject should serve to prolong the success of these meetings indefinitely.

Pavement Explosions

A REPETITION of pavement failures all alike and all apparently from the same cause, such as are described in this issue in the brick and concrete road in King County, Washington, is seldom recorded. The occurrence is not unique, except perhaps in respect to the explosive violence of the ruptures. On a bituminous road on a concrete base, recently observed, a substantially similar repetition of surface and base ruptures has occurred. Other examples are remembered. In all the explanation has been: difference in the rates of expansion of base and top and lack of expansion joints—which is no explanation. All pavement slabs expand and contract and except here and there they are serving their purpose without repeated ruptures, both with and without expansion joints and over a period of years. There is some more obscure condition than exists in the ordinary brick or bitumen or concrete road, which induces the disastrous results from expansion that are recorded on the King County road. It would be interesting to learn what it may be. As a matter of fact, however, the importance of getting the secret is not particularly great. Too few brick or concrete roads fail in the manner described to make the knowledge why they fail worth much. Nor is it of much significance that an occasional failure of this character is experienced and it should by no means be accepted as a reason for passing judgment on any type of pavement.

The Stadium—An Economic Anomaly

OHIO STATE UNIVERSITY has done well in attempting to utilize some of the space in and around its new athletic stadium for full-time service. Gymnasiums, swimming pools, indoor tracks, offices, drill halls, are all part of the necessities of a college which might be housed under the ample roof formed by the sloping stands and thus make these popular structures somewhat less of an economic anomaly than they now are. At Columbus this week fifty or sixty thousand enthusiastic rooters will witness the dedication of the new stadium. Once a year, probably, certainly not more than four or five times a year, will the sixty-odd thousand seats be filled, but no doubt in common with most other college stadiums its cost will be paid by the admissions to the first few games staged. So long as the books show a profit it would be quixotic to protest against such waste of use or to note that for a few hours' amusement the community is paying out a sum which would endow many chairs in the college or maintain a hospital. Only a misanthrope would deny the right, and probably the duty, of man to spend some of his substance in vicarious recreation; the ball park needs no moral or economic justification. The crime of the stadium is its occasional use and that might be averted by a more extended application of the Ohio plan. Thus may be partly obscured the reproach of a million or more lying idle three hundred and fifty days in the year in a community which finds it difficult to pay its leaders a living wage.

Planning for Efficiency

WHAT has been done at Ohio State University toward developing at some future time the indoor-space possibilities of the stadium is but one phase of exceptionally careful planning that preceded its construction. Without deprecating the kind or amount of thought embodied in earlier college stadiums we may give the Ohio structure special distinction for the degree to which efficient and economical construction were made the objects of detailed study in the course of its design. The plan which resulted from this study was worked out, not conceived in a flash of creative imagination. The engineer's method rather than that of the architect was followed. Yet it does not appear that any loss of architectural effect was suffered, for in point of harmony, dignity and impressiveness the Ohio stadium is second to none—to our own taste, we hasten to add, since esthetic appreciation is notoriously variable. Fortunately, individual judgment can be based on the drawings reproduced in this issue. They also supply the data for judging of the success or lack of success of the planning for efficiency in space and structure. Against all college field traditions a two-deck arrangement was adopted—a feature likely to become the regular thing in very large stadiums. An interesting composite construction of part steel frame and part reinforced-concrete frame was used to save time and money, and it is worth special note that its economy was checked by bids on an all-concrete design. The anticipated advantage of being able to hasten construction by erecting the steel frame during the winter was fully realized in actual execution. The expansion problem, which has been a source of many troubles in the past, was dealt with in radical fashion, by putting in

full cross-joints every 60 ft. and closing them off with an elastic seal. Practically all prior stadiums have proved seriously defective in their treatment of expansion, and the Ohio solution was adopted only after the designers had visited nearly all of them, to study the practical working of other methods. In fine, the Ohio stadium is noteworthy in many ways, and unless its service performance belies all present promise, it will create precedent in stadium design.

An Innovation in Arch Centering

FALSEWORK for engineering construction is marked usually by an extravagant use of material rather than by intelligent design. The practice is a relic of the day when timber cost little and neither economy of use nor salvage after use was an object of much monetary significance. Then arches were "filled with timber" and the contractor proclaimed the safety of his centering by asseverating that "you couldn't chase a rabbit through it." It is the recollection of this ancient practice, which has been by no means discontinued in modern times, that gives the precisely designed timberwork of the Beechwood Avenue Bridge center, described on another page, the appearance of supreme boldness. What the contractor did here was to design a framework without superfluous members to carry a determined load, combining timber and steel so as to put each material to its most economic service. Timber was used for posts and struts and steel for ties and beams and for the connections of the two materials at joints. In fact the designer did no more than produce in steel and wood instead of steel altogether the type of structure commonly known in its early days as the railway viaduct, represented first by the Kinzua Viaduct and later by the Pecos Viaduct and since by scores of similar structures all over the United States. The centering was bold in no greater degree than were its prototypes in steel so long as the designer kept safely within the strength properties of the materials which he employed and fabricated his combined timber and steel structure with approximately the precision with which all-steel structures are fabricated.

Water Supply at Panama

IN VIEW of misgivings, rarely voiced but widely circulated, as to the water supply of the Panama Canal, Mr. Baxter's discussion elsewhere in this issue is of particular interest and value. Especially is it helpful to learn that of the water flowing into Gatun Lake during 1920, the driest year of record since the lake was formed, 12 per cent only was used for locking, while 26 per cent developed power and 47 per cent was wasted. Further development of the watershed, already projected, will save much of the waste and will provide for power generation without diverting the flow from lockage use. Meanwhile the reserve steam-plant at Miraflores stands ready to release some of the water used for power whenever it is needed for lockage. All things considered, Mr. Baxter concludes that with the projected development of the Chagres watershed the operating capacity of the locks will become the limiting factor rather than the water supply. The date on which this limit may be reached cannot, of course, be estimated with precision but the conclusion to await a more evident trend of traffic growth is sound and conservative. Mr. Baxter performs a service in reminding us that the narrow and tortuous sea-level channel considered fifteen years ago could not begin to meet present and prospective needs, and that a genuine "Straits of Panama" would involve difficulties and expenditures quite unwarranted by any demands now in sight. His article deserves a thoughtful reading not only by engineers but also by all those who may be seeking an antidote for the alarms as to the canal's future.

A Significant Resignation

IN DR. S. W. STRATTON the Massachusetts Institute of Technology is getting something more than the scientist it has been its custom to select for president. Trained though he has been as a physicist Dr. Stratton's greater reputation rests on his remarkable success as an administrator of that government bureau which he developed from a mere office of weights and measures to a research institution with personnel and equipment rivaling many a university. The Bureau of Standards is Dr. Stratton's work. That after twenty-one years service to it he should leave for other fields, however attractive, is significant evidence of what is happening in the technical service of the government. It is reported that he is to receive a salary three times what he has been getting at Washington, which, coupled with the honor and opportunity for service in the new position, is enough to influence any man's decision. But we believe more potent than the personal element has been the realization of the hopelessness of getting Congress to provide adequately for the enormous research plant that has grown up on Cleveland Heights. The institution which Dr. Stratton has fairly wrung from a reluctant Congress has enormous potentialities of service, but so niggardly have been the appropriations since the war that one by one the experts who serve it have been leaving, like their chief not so much because of the greater pecuniary rewards elsewhere—for to men of the true research spirit pay beyond a competence is not irresistible—but because the lack of money for assistance and equipment makes of their work a drudgery which is the breaking straw added to the low pay common to all government technical service. Dr. Stratton's resignation is a protest that Congress cannot well afford to disregard.

The Direct-Oxidation Process

CONSIDERING the time, money, oratory and printers' ink lavished upon it, no method of sewage treatment yet commercially promoted in the United States has been so coldly received by engineers as the Landreth direct-oxidation or lime-electrolytic process. The reasons are not far to seek. The electrolytic processes (without lime) of Webster, L'Hermite, Woolf and Harris had been tried and found wanting during the quarter century of promotion effort in England, France and America before lime treatment and electrolytic action were joined. Lime treatment, after decades of wide use in various countries, had been passed by in the case of new sewage-works and given up at many old plants because it increased the sludge problem—long ago characterized as the crux of the whole matter of sewage treatment. These two facts made engineers skeptical as to the proposed combination of two processes, one regarded by them as never successful and the other largely superseded.

That skepticism was far from dispelled by the small Landreth test plant at Elmhurst, Borough of Queens, New York, and by the larger demonstration plants of the same type at Decatur, Ill., and Easton, Pa. The

report on the Easton plant by the Engineering Division of the Pennsylvania Department of Health left the lime-electrolytic process still in doubt, as regards cost and the sludge problem. The Franklin Institute test at Easton—and its gold medal award—was not taken seriously by well-informed engineers, except as they thought it a serious matter for the Franklin Institute to award a medal in the light of the facts, existing or lacking.

The conditional permits granted by the New Jersey and Pennsylvania Departments of Health for direct-oxidation plants at Phillipsburg, N. J., and Allentown, Pa., the former after an application had been denied, did not add to the confidence of engineers in the process, nor did attempts to exploit the results at the two plants when being operated at only a small percentage of their capacity. Although the Phillipsburg plant has been nominally in operation for some two years, it was not until a few months ago that the New Jersey Department of Health began the long-expected test called for by the conditional permit (report on which has not yet been made public), while the Pennsylvania Department of Health has not yet passed upon the Allentown plant.

In the light of the foregoing statements it is not strange that when the direct-oxidation process came before a considerable number of consulting and municipal engineers at the recent Cleveland meeting of the American Society of Municipal Improvements (see abstracts of papers and discussion elsewhere in this issue) no warmth for the process was shown by anyone except the engineer of one of the two cities where there is a Landreth plant in use and by the only consulting engineer who, so far as we can recall, has ever recommended to a city the adoption of the direct-oxidation process.

Meager indeed were the data offered by either of these engineers in support of the physical or financial efficiency of the direct-oxidation process, although reference was made to a test of the Allentown plant extending over some weeks. Presumably these test figures will be made public before long. It is also to be hoped that the results of the Phillipsburg tests, already mentioned, will be given out by the New Jersey Department of Health as soon as it takes official action on the plant.

The skeptical opinion on the Landreth direct-oxidation process, both as expressed at and before the Cleveland meeting, has not been due to the fact that the process was being commercially promoted as one of the speakers at Cleveland held, but rather that it was being over-promoted and that on meager data and with too little regard to the teachings of the past and the rational demands of the present in the art and science of sewage treatment.

Reaction Against Standardization

ONE need not lack faith in the benefits derived from industrial standardization to recognize that the process is, in a measure, at odds with progress. Progress depends upon original endeavor, upon doing things differently; standardization forbids doing things differently and asserts that original endeavor is quite unnecessary and disturbing. When one shape, one type, one way of doing a thing has officially been decreed best, and mass momentum is brought into action to make it exclusive, progressive thought on the subject matter will largely be paralyzed, or else diverted to other fields. Also, directed study in connection with the standardization object will shrink to a minimum. Research is antipodal to standardization.

These reflections are awakened by an English contemporary's plaint over the lack of originality, the mental deadness, which (it charges) characterizes bridge engineering. Standard designs, it asserts, are welcomed by men who lack imagination, and these men will make no effort to change such designs or develop original designs. This statement seems to refer primarily to conventional bridge types that have become established through commercial processes, but to some extent also to standard specifications for bridge design, for in another sentence there occurs a sharp allusion to the doubtful wisdom of framing such specifications. The remark is meant for English conditions, presumably, but it might furnish food for thought west of the Atlantic as well, were our bridge engineers not somewhat touchy just now on the subject of time-honored design practices, as in the case of the Cooper loading.

The complaint probably has more of a temperamental than a real basis, so far as the bridge engineer's special art is concerned. It is a matter of common knowledge that no branch of civil engineering displays as much originality and creative thought as this one. The real significance of the complaint lies in the fact that it reasserts the old truth known to all, but often ignored, that engineering design and construction are creative processes, and as such are at war with conventions and standards.

Protest usually is the expression of a hurt, somewhere or other. In the present case it is pertinent to observe that the complaint comes from a land where uniformity of practice in engineering or its allied industries has ever been abhorred and everyone has gloried in doing things differently, and where, as an offset to this condition, standardization in the mechanical industries was first put on a wholesale basis. The work of the Engineering Standards Committee, recently re-formed as an association, has extended over an almost unlimited range, and, far from being confined to matters involving interchange or economy of production, it has gone into fields where uniformity of practice is little more than an ideal objective. Hitherto the prevailing sentiment of industrial and engineering circles appears to have supported the work. The present protest, whose real point is directed against this all-embracing standardizing movement, is the first open demand that engineering originality, creative design, be left undisturbed.

Is it an early symptom of a reaction against the standardization movement? The two points of originality and research are brought to the fore as they inevitably must be whenever free, active development is contrasted with routinized procedure and the stagnation which it entails. Even in bitterly unjust assertions, as in the charge that engineers build bridges "with as much regularity as a baker turns out standard buns," the English protest voices the exasperation caused by the attempt to make engineering creation subject to standardized method.

Here in the United States we are only beginning to standardize. Discussions have dealt chiefly with industrial standardization, but already the attractive and promising process is extending to matters of engineering design, where judgment and individuality are decisive factors, as they are in bridge construction. For this reason it can be of much value for us to observe that attention has been called to the essential antagonism between engineering and fixed convention, and that a call is voiced for return to originality of effort and resumption of research inquiry.

Ohio Stadium, a Double-Deck Steel and Concrete Horseshoe

Structure of Novel Design Planned for Compactness and Quick Construction—Space Under Seats for Indoor Activities—60-Ft. Expansion Sections—Outside Steel Covered with Concrete

THIS week one of the important football games of the Mid-West College Conference will be played in the new stadium of Ohio State University, which has just been completed. This latest addition to the great college arenas is unique both in its general planning and in its structural features. The design represents an original answer to the question of how the most efficient arrangement of seating for the vast crowds which witness large college games is to be secured and how the structure should be designed for most impressive appearance as well as for economy of construction and permanence. from the destructive and annoying expansion and contraction effects experienced in earlier stadiums. This feature, and the protection of all steelwork open to the weather by concrete inclosure are believed to insure permanence and minimize the cost of maintenance.

Location and Plan—The stadium is located in the valley which separates the main group of buildings of the university from the Olentangy River. Its axis was laid out practically north and south, the open end of the horseshoe facing the south. The site was submerged in the flood of 1913, but subsequent river improvement

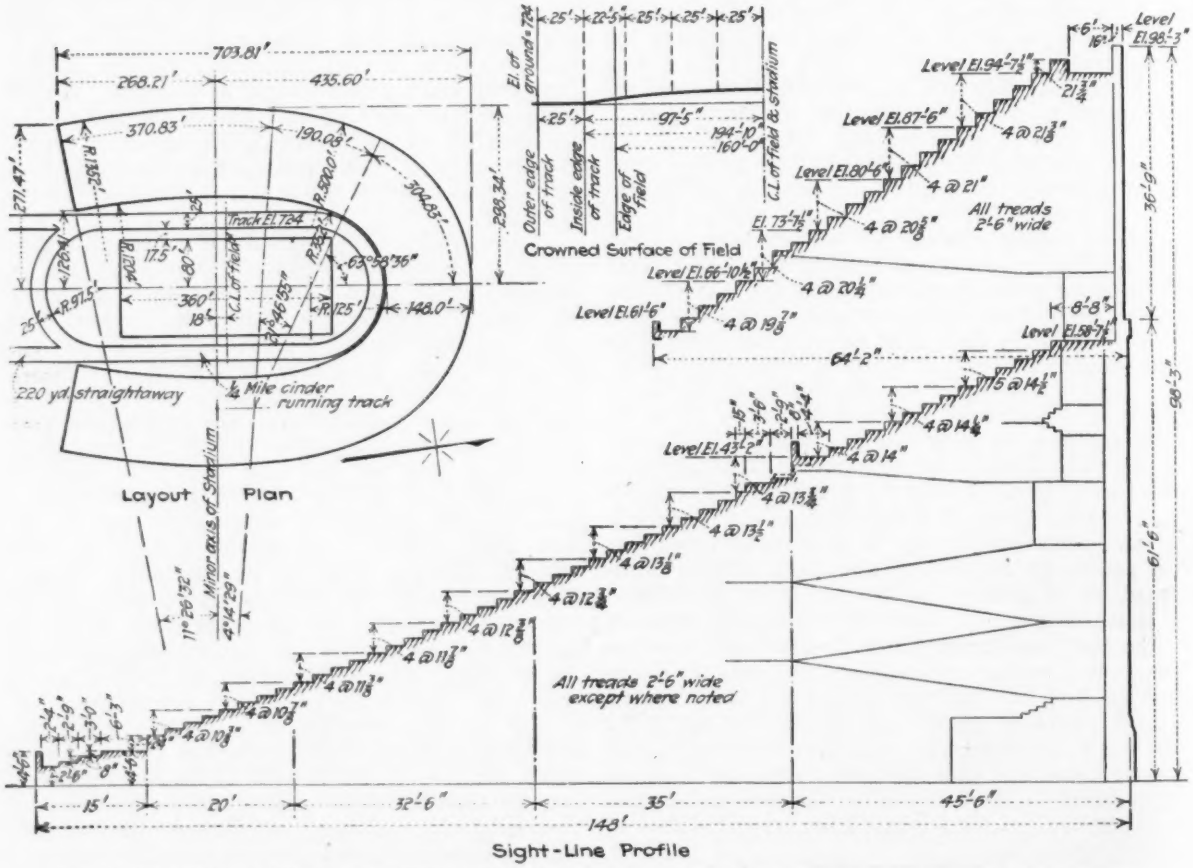


FIG. 1—GENERAL LAYOUT AND SIGHT LINE PROFILE OF THE NEW STADIUM AT OHIO STATE UNIVERSITY

Horseshoe shape with bowed sides and double-deck arrangement—in which latter point the Ohio stadium differs from all other college athletic stadiums—are the striking elements of the design as regards best adaptation to purpose. Steel framing and reinforced concrete were used in skillfully arranged combination, for economy and for most rapid construction, as the steel framework permitted uninterrupted erection during the winter. The structure has been designed, further, to permit of extensive use for indoor athletic activities of the students, by developing the inclosed space under the seat banks. A thorough treatment of the expansion-joint difficulty is believed to eliminate all future trouble work in Columbus has reduced this flood hazard to a minimum; during the flood of last April, when more water passed through the river channel than at any time since 1913, the playing field (el. 725) would again have been overflowed had the river improvement work not been completed. It will be further protected by a boulevarded dike along the river bank.

The general arrangement of the structure embodies what the designers have called the Ohio plan, comprising an open-end horseshoe shape of structure with bowed sides, and double-deck seat banks. The bowed sides give the double advantage of a slightly better angle of vision and a comprehensive view of the entire crowd, and are

expected to enhance greatly the inspirational effect of the great assemblages of people in holiday spirit. The double-deck idea is not new in baseball grandstands, but has never before been used in a college athletic stadium. It brings one-third of the seats about 50 ft. nearer to the playing field without materially increasing the height of the structure; in addition it reduces the ground area covered and provides protection from the weather for about one-third of the seats.

A plan of the stadium is shown in Fig. 1. The structure is about 704 ft. long by 597 ft. wide over all, and incloses a space 556 ft. long by 294 ft. wide. The gridiron field of 170 ft. by 360 ft. is surrounded by a quarter-mile track 25 ft. wide, with straightaway extentions at the open end of the horseshoe. The profile of the seat banks is hollow, to give the upper seats full command of the field; it was so worked out as to enable every spectator to see the middle of the track, over the heads of those in front of him. By arranging the aisles and entrance stairs at the columns, obstruction of view by the columns has been almost eliminated.

The stadium will seat about 62,000 persons (3,100 box chairs, 59,000 regular seats). The total length of seat bank exclusive of aisles is about 90,000 lin.ft.

Adapting the space under the seat banks for future development for indoor athletic activities increased the cost of the structure somewhat, chiefly by necessitating wider column spacing than would have been most economical and by making it necessary that the seat banks should be watertight. By closing the arch openings in the outside walls with steel sash and glass at some future time the interior will be fitted for use for intramural sports such as basketball, handball, squash, winter trackwork, and the like. Under the west seat bank a six-lap cinder track and a 100-yd. straightaway have been laid out, also for future construction. Ornamental rectangular towers which form the south termination of the end of the horseshoe will provide space for offices for the athletic department of the university, as well as shower and locker rooms for the athletes; each south tower will accommodate about 500 lockers, so that not only the regular athletic teams but also other students registered in intramural athletics can be taken care of. There are frequently as many as 1,000 men participating in intramural sports at Ohio State, and the hope of the authorities is that all students may ultimately join in the athletic work in some degree.

The wide spacing of the columns necessary to accommodate these various activities made a steel frame more economical than a reinforced-concrete frame. Also, the time necessary for building the stadium was shortened

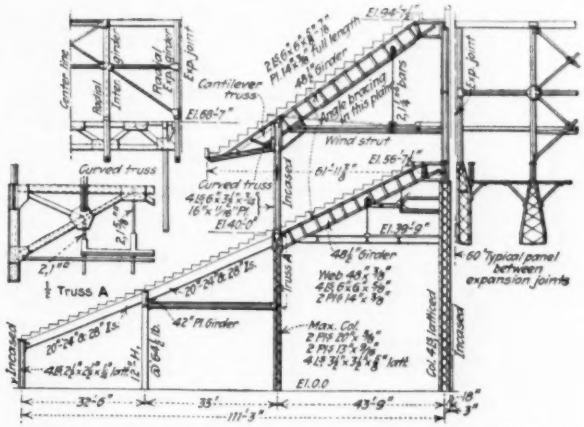


FIG. 3—STEEL COLUMN-AND-GIRDER STRUCTURE PERMITTED WINTER ERECTION

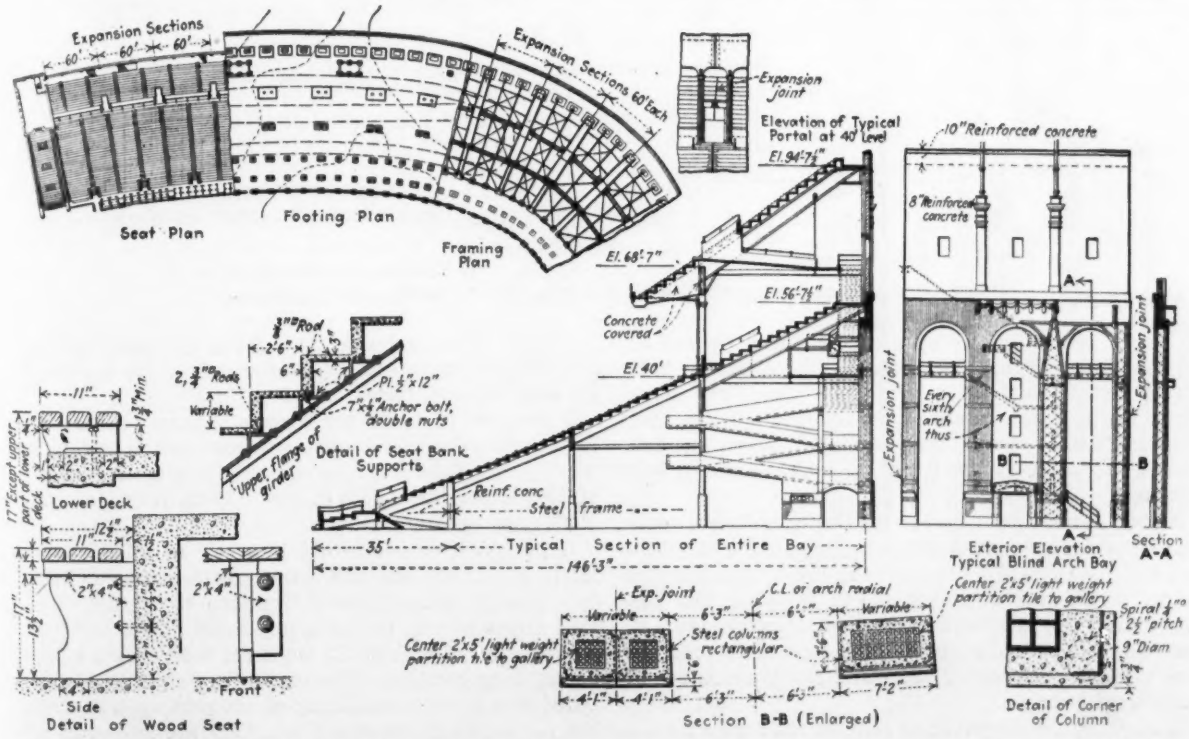
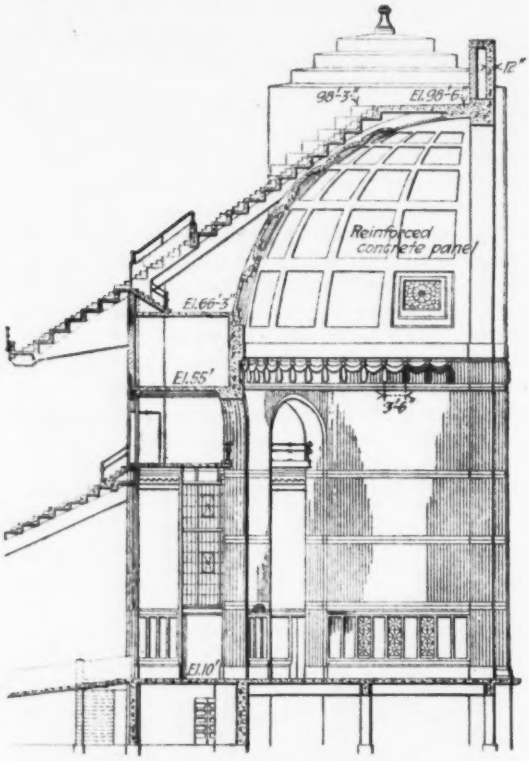
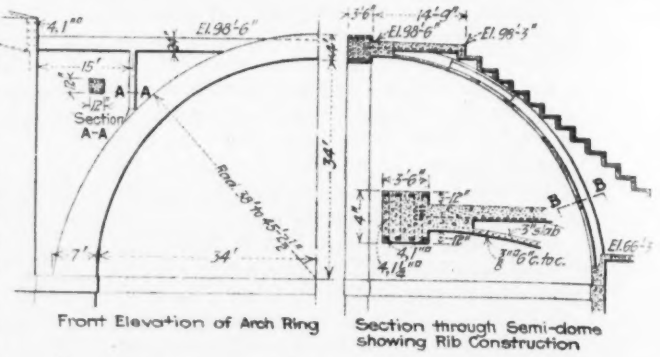


FIG. 2—GENERAL DETAILS OF OHIO STADIUM—REINFORCED-CONCRETE SEAT-BANK SLABS SUPPORTED ON STEEL FRAME INCLOSED WITH CONCRETE WALLS

by about a year through the use of the steel frame, because the steelwork could be erected during the winter months, when concrete could not conveniently be placed. The structure of the stadium therefore is a somewhat unusual composite of steel and reinforced concrete, as may be seen from the sectional drawings in Fig. 2. The lowest portion of the seat-bank structure, comprising space for boxes and eight rows of seats, is wholly of reinforced concrete. The structure beyond this point consists of a series of radial steel bents built up of columns, girders and beams, spaced 20 ft. apart along the outer circumference, topped by a reinforced-concrete seat-bank slab spanning from bent to bent, and closed off at

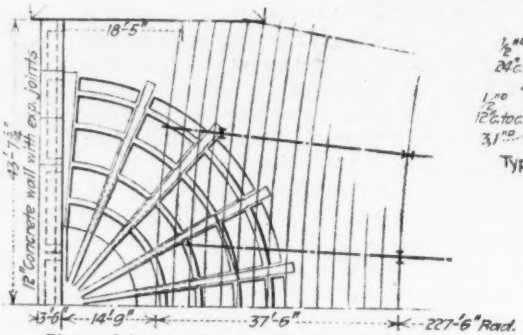


Section through North Entrance

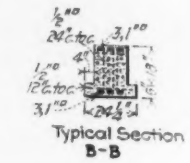


Front Elevation of Arch Ring

Section through Semi-dome showing Rib Construction



Plan of Dome showing Rib Construction



Part Roof Plan

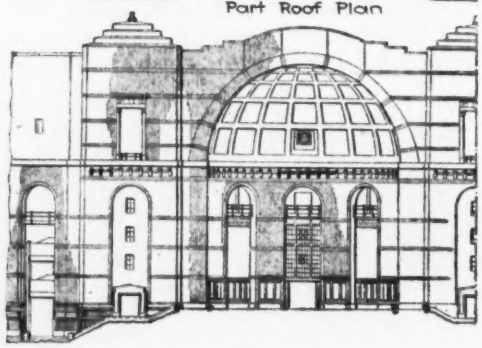

Elevation of North Entrance

FIG. 4—CONSTRUCTION ELEMENTS OF HALF DOME AT CROWN OF HORSESHOE

the outer circumference by a concrete wall pierced by high arch openings. The bents on 20-ft. spacing have direct column support only at their outer and inner ends, while at the intermediate lines of support they rest on trusses or girders spanning between columns placed only at every third bent, or approximately 60-ft. spacing.

Detail Points of the Structural Design—Plate girders and rolled beams were used for the supporting members not entirely covered by concrete, in order to reduce the deterioration due to rusting and to facilitate painting. No unprotected steelwork is exposed to the weather, all outside columns and girders being incased in concrete. Doors, walls, seat banks, stairs and passageways are of reinforced concrete.

Designing the steelwork to support the forms for the concrete work made it possible to eliminate most of the shoring and scaffolding that would otherwise have been required. The steelwork also served for carrying the necessary hoisting engines and travelers for handling the concrete and forms (see Fig. 6).

A live-load of 80 lb. per horizontal square foot, with 25 per cent added for impact, was assumed in designing the frame. This figure corresponds to a total live-load of 250 lb. per lineal foot of seat (30-in. length of step from riser to riser).

Expansion Provisions—At intervals of 60 ft. along the length of the stadium a transverse expansion joint cuts through the structure from top to bottom. The steel frame as well as the concrete slab, floor, and wall construction of each 60-ft. section is independent of the neighboring sections. The expansion joints are so detailed that there is no sliding of one part upon another, but the adjoining slabs and members are supported by twin columns and girders (the separation in the steelwork may be seen in Fig. 5). The concrete of adjacent

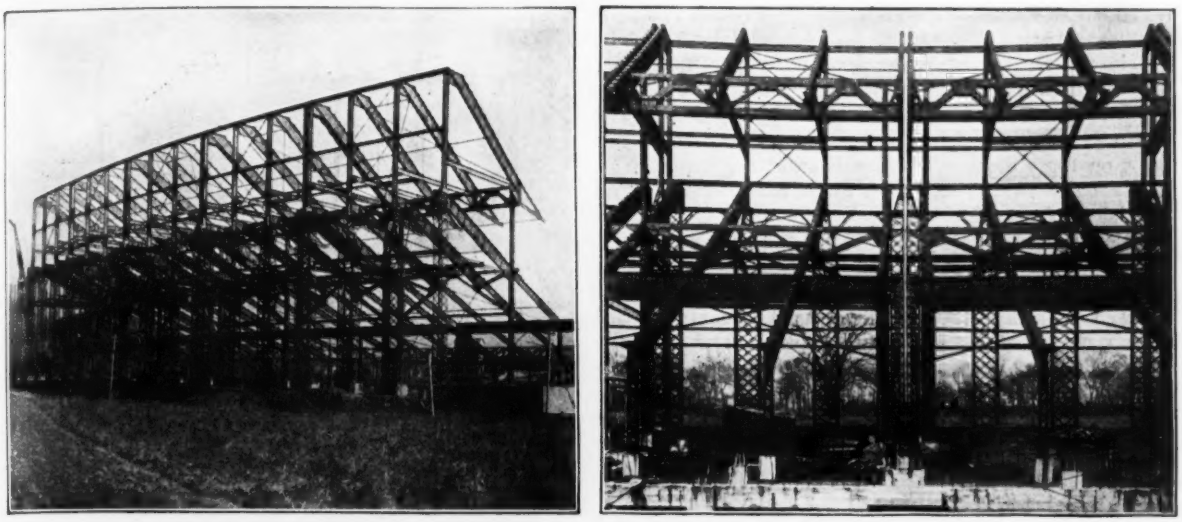


FIG. 5—TWO VIEWS OF THE STADIUM STEELWORK AS IT APPEARED LAST SPRING

sections is separated about ¾ in., the thickness of an ordinary form board, and this opening is closed by a U-shaped lead sheet bedded in the concrete, over which the joint is filled with asphalt mastic. Where the joint goes down through the outer wall, no lead strip is used but the joint is filled with ¾-in. premolded bituminous joint filler. This feature is clearly shown by the details in Fig. 8.

Foundations—Excellent boulder gravel for the foundation occurs near the surface on the east side of the structure and 10 to 14 ft. below ground level (or about 4 ft. below ground-water level) on the west side. All footings were built as spread footings on this gravel, except in a few small isolated footings where it was simpler to stop the structure at a higher elevation and drive concrete piles through the upper strata to gravel.

Soil bearing tests showed gratifying results; a pressure of 7½ tons per square foot on the gravel, maintained for a week, showed no settlement after application, although water was allowed to rise in the hole and was pumped out repeatedly. The footings were proportioned for a maximum dead- and live-load pressure of 4 tons per square foot. All footings were proportioned on the basis of the dead-load bearing area, for a unit pressure slightly under 2 tons, fixed by the maximum of 4 tons per square foot.

Main Entrance—At the north end of the structure is the main entrance, a great half dome 70 ft. in diameter and 85 ft. high, flanked by towers accommodating ticket offices, rooms for spot lights, flood lights, radio apparatus, etc. The design of this half dome was an interesting problem because of the necessity for providing for the outward thrust at the crown. The thrust is taken care of by a horizontal slab directly over the crown of the dome, at the top of the upper deck, which is designed to act as a horizontal girder capable of carrying this thrust.

The dome is framed with a face arch of semi-circular intrados of 68 ft. diameter supporting radial half ribs of generally T-shaped cross-section, joined by horizontal ring girders of concrete. The panels between ribs and ring girders are filled by separately molded concrete slabs of ornamental design. At two points the upper ends of the seat-bank girders of the upper deck had to be supported on the dome, for which purpose a short horizontal I-beam was placed so as to span between adjacent ribs, and the seat-bank girder was supported on this beam. Two other seat-bank girders which project over the dome area were carried by columns just back of the springing line of the dome, cantilevering backward over these columns.

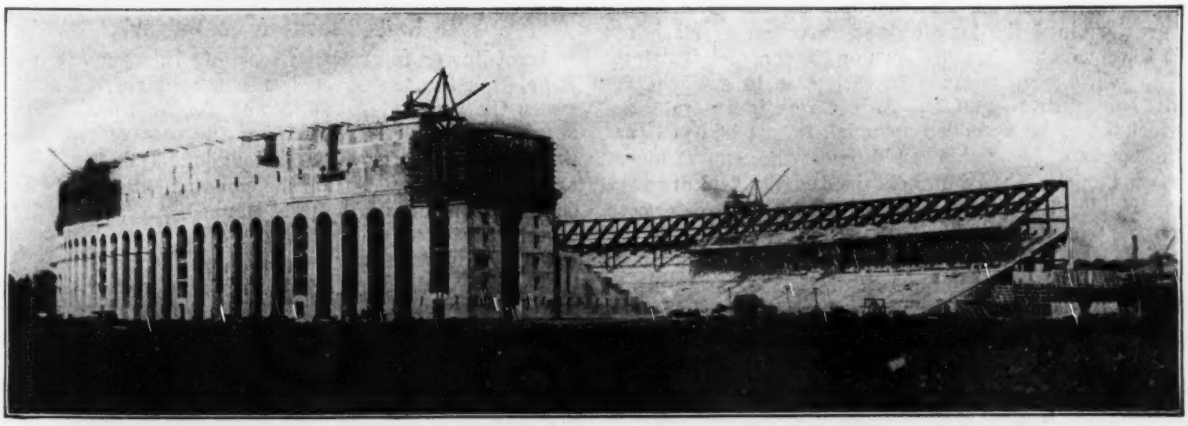


FIG. 6—CONCRETING IN PROGRESS; TRAVELERS ON UPPER DECK HANDLING FORMS AND CONCRETE

Seats and Ramps—The concrete steps which form the seat banks are uniformly 30 in. wide radially but vary in rise; those on the lower deck have rise increasing from 10⅜ in. at the bottom to 14½ in. at the top, while those of the upper deck have a rise increasing from 19⅝ in. to 21¼ in. Wooden seat benches without backs are built on these steps. The bench seats are made of 1⅞ x 3-in. oak strips, spaced 1 in. apart for drainage. The provision of free drainage and opportunity for air circulation are expected to prevent warping and decay.

Entrance to the structure is afforded at six points on each side of the horseshoe. As tickets are to be taken at each entrance, the distribution of the crowd will largely occur outside the structure itself, and the need for distributing passages within the stadium is minimized. A combination of stairs and ramps at each entrance gives access to two circulating galleries in the rear of the structure, one, at El. 39 ft. 9 in., to feed the upper half of the lower deck, the other, at El. 67 ft. 10½ in., to feed the upper deck. The lower half of the lower deck will be fed direct by entrances from the field side of the structure. The passageways and ramps are 5½ ft. wide, and generally they are U-shaped structures with the vertical handrail portion serving as longitudinal girder.

Position of Forms Prescribed by Designer—No effort has been made in construction to obliterate or rub out

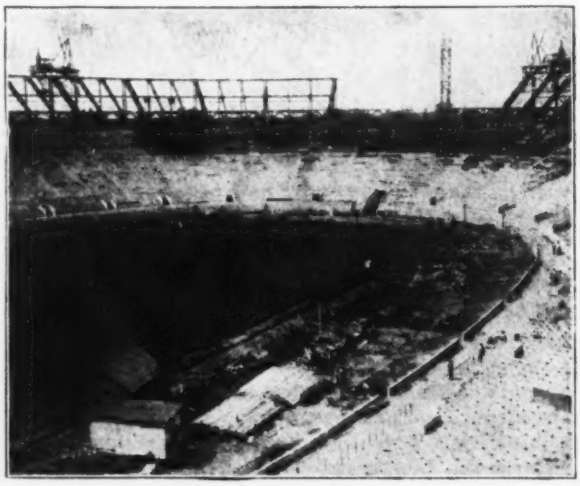


FIG. 7—INTERIOR OF NEARLY COMPLETED STADIUM

the form marks on the concrete surfaces. The design predetermined the location and direction of all joints in the forms, which was shown on the contract drawings. The joints were planned in each case to give the desired architectural effect. As concrete is generally appreciated to be a molded material, it was believed that the marks of the molds would be a frank expression of the material. The results obtained in the field are very gratifying, the effect produced being satisfactory in every respect.

Playing Field—The field inclosed by the stadium is surfaced with 2 ft. of top soil drained by 4-in. tile in herring-bone arrangement 6 ft. apart, 18 in. below the surface. The fill below this level is cinders and miscellaneous excavation soil. As shown in a small sketch in Fig. 1, the football gridiron is crowned 12 in. in its width. The quarter-mile running track around the field

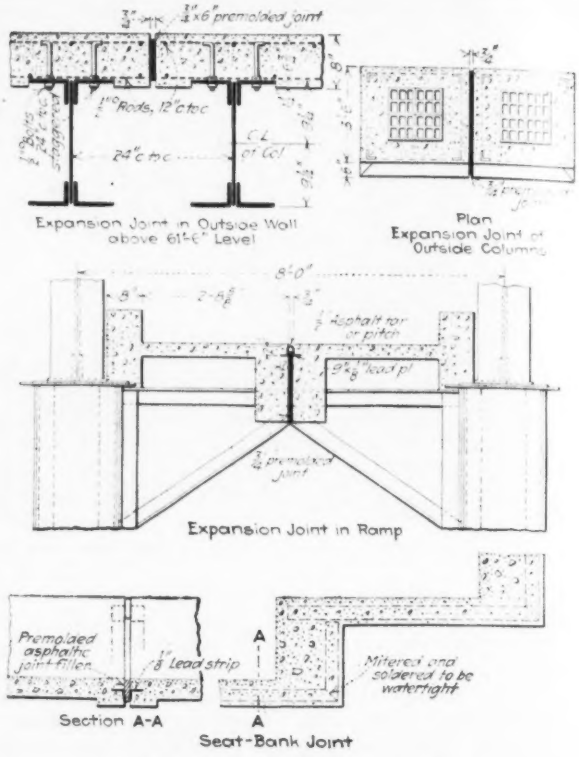

Expansion Joint in Outside Wall above 61'-6" Level
Plan Expansion Joint at Outside Column
Expansion Joint in Ramp
Premolded asphaltic joint filler
Lead strip
Mitered and soldered to be watertight
Section A-A
Seat-Bank Joint

FIG. 8—EXPANSION JOINT DETAILS

consists of the usual gravel base and cinder surface.

The stadium is being built by the Ohio Stadium Building Committee, with Clyde T. Morris, professor of structural engineering at Ohio State University, as engineer, and Howard Dwight Smith as architect. W. F. Hindman is assistant engineer in charge of the field work. The contract for the construction was taken by the E. H. Latham Co., of Columbus, on a lump-sum profit-sharing basis. The total cost of the stadium, the surfacing of the playing field, and all auxiliary items will be about $1,500,000.

About 4,300 tons of structural steel and 25,000 cu.yd. of concrete were required for the Ohio stadium. The contract for construction was signed July 7, 1921, and ground was broken Aug. 3. Dedication of the completed stadium is to be celebrated at the football game between Michigan and Ohio State on Oct. 21.

To Build Elevators in Bulgaria

According to information reaching this journal from Sofia, Bulgaria, an agreement has been arrived at between the Agricultural Bank and the MacDonald Engineering Co., Chicago, regarding the construction of a line of 60 grain elevators throughout Bulgaria. The agreement is now before the government's legislative body for consideration. It is planned to construct during the first five years elevators of a total capacity of 160,000 tons with a view ultimately to doubling the capacity. Funds are to be obtained by a loan of £2,000,000 (English) placed through the Agricultural Bank abroad. Present plans contemplate the construction of two elevators and two dryers at Black Seaports, 12 elevators on Danubian ports and 46 elevators in the interior.

Lost Time in Construction—3

Rain and Mud Delays

Delays Analyzed — Remedies Enumerated — Drainage, Machine Design, Trackways, Housing, Waterproofing, Drying Methods Offer Possibilities — Problem Calls for Research

By **C. S. Hill**
Associate Editor, Engineering News-Record

Third of a Series of Four Articles

RAIN and the consequent result, mud, in all operations where the condition of the ground surface is a factor in construction, are, next to winter idleness, the principal causes of lost time. The amount of time lost annually because of rain and mud delays is difficult to estimate. There are few statistics. Indeed except for highway construction they are non-existent. This makes it extremely difficult to appraise the problem. In fact about all that can be done is to visualize it by inference from occasional records and general knowledge.

Delays caused by rain are of two sorts:

1. Interruption due to storm itself: i.e., violent or persistent fall of rain or combined wind and rain, and

2. Waiting to recover from the effects of rain, i.e., waiting for the mud to dry, for flooded workings to be pumped out, for washing or scouring to be repaired, and for equipment to be cleaned and dried.

The weather and the character of the work determine the magnitude of both kinds of delay and the relative importance of each. It is plain for example that rain counts for little in hydraulic dredging and is a great hindrance in building a concrete road. Other contrasting examples are readily called to mind. In all, one outstanding fact is evident; it is the consequences of rain and not the stormy condition itself which are responsible for the greater loss of time. This truth will be more evident as the argument proceeds. It is important to get it clearly in mind because it indicates the only possibility of solving the problem.

Obviously prevention cannot be considered. The rain will come as it happens. Whenever it comes it will bring certain consequences. Most disturbing of all, it soaks the ground and makes mud. But it also damages materials, as for example cement; it runs into the workings, like footing pits and trenches; it makes objects slippery and awkward to handle; it washes and gulleys embankments and finished grades; it injures structure, like newly laid concrete; it wets the work going on and prevents construction until the moisture has been dried—a brick pavement, for example, rained on has to be dried before the bituminous filler can be applied; it makes it necessary to clean and dry tools and machinery to prevent rust and keep them in good condition. Finally, of course, men object to working, and sometimes cannot work, when the rain is falling.

Ordinarily the storm conditions themselves do not often completely stop work and less often do they stop it for any considerable period. Rain in the summer comes usually as showers. The showers may be frequent and rather violent while in progress but they do not last long. Could we imagine the dry condition just before the rain to be restored immediately after it ceased to fall, rain would not greatly delay construction processes. Of course in the early spring and late fall rains are more continuous, and the delays due strictly to storm are more protracted, but even then, were the effects eliminated, work would not often have to be altogether abandoned. As a hard-bitten old earth mover once put the fact to the writer, "We don't stop work because it rains but because the rain is wet."

All that has just been said is distinctly elementary but a clear understanding of the facts in detail is vital to a definite statement of the problem to be solved. This problem is essentially to guard against and moderate the *consequences* of rain. Four general methods suggest themselves for consideration:

1. Employ equipment and methods unaffected by rain.
2. Modify engineering requirements for wet weather construction.
3. Employ means for diverting or shedding rain water or for drying wet surfaces.
4. Housing or sheltering the work from rainfall.

Contemplating these several methods broadly it is evident that their possibilities depend upon the conditions and character of the operation. Altogether, however, there are not many kinds of construction where some protective or defensive measures of the sort enumerated are not to some extent practicable. This requires, however, that the operation be planned for the probability of wet weather as well as for sunshine. It is the contrary practice that largely causes a rainy season to be so completely upsetting when it occurs.

Construction operations, in respect to the disturbance caused by rain, may be grouped under (1) earth moving, (2) road building, and (3) general construction. In fact, in operations (1) and (2) are included substantially everything. We do not need, ordinarily, to consider dredging, tunneling or interior building work. The building of concrete structures, steel erection, timber work and structural work generally are affected by rain only as storm affects the comfort and safety of the erecting crews and consequently their efficiency and as wet roads may interrupt the delivery of materials.

Earth Moving—Water-soaked soil and mud hamper earth moving operations by increasing the weights to be handled and by clogging buckets and other excavating tools, but chiefly by hindering the movement of men and teams or machinery over the ground. Saturation affects soils differently. Sand and gravel give a firmer footing when they are wet. Clayey soils, gumbo and alluvial silt, turn into mud. All soils are made heavier by saturation.

Among the possible remedies previously enumerated it is evident that housing is not widely possible and that drying processes are ordinarily impracticable.

Drainage first and, second, the use of machines and hauling methods unaffected by soft ground are the obvious procedures.

Drainage is logically the first resort of the earth mover in protecting his work. It has a considerably different purpose than ordinary ground-water drainage of pits, and cuts. Its primary object, for the purpose here considered, is to divert run-off or surface water from the workings and its second is to get quickly out of the workings the undiverted surface water; it is only its last purpose to care for seepage. The first step in improving methods of wet weather earth moving requires us then to:

1. Study of methods of diverting surface water from pits and cuts by ditches and of removing undiverted water from the workings.

Mud and most water-soaked soils hinder and endanger the movement of equipment, and, particularly, all hauling operations. There are two ways of overcoming this difficulty. One is to employ machines capable of traveling over soft ground. The other and the more important way is to provide solid tracks.

In machine equipment the most important development of years is the crawler traction. Non-clogging or self-cleaning buckets and conveyors for excavating machinery are a second line of development. A third improvement, in the respect that it reduces haulage to serve the machine, is the substitution of gas-engine and electric power for steam power. Most of these improvements have been prompted more, or quite as much, by other reasons than avoidance of bad-road troubles, but they cover this purpose also. In brief, earth moving equipment is designed primarily for dry weather operation and is provided as a secondary consideration with devices or attachments to meet certain outstanding wet weather requirements.

The second task of improving wet weather excavating methods is then:

2. Review earth moving machinery design with the fact in mind that it must operate probably a third of its time in rainfall or in material water-soaked or made muddy by rain.

Ordinarily in excavation the surface condition of the ground affects the hauling service to and from the excavator more seriously than it affects the excavator itself. Track or hard road construction is the obvious remedy. The vehicle itself has been improved to some extent, as by crawler traction or wide tired wheels, but this is not the logical line of development. This is to put the vehicle on a track or a hard road. Such service roads are temporary and require more or less frequent change of location. These requirements indicate the third task which has to be performed:

3. Investigate the design of service railways, plankways, etc. (1) to improve their strength and rigidity and (2) to perfect their portability; determine at the same time the best practice in constructing, keeping up and shifting service railways.

It deserves emphasis that some form of trackway is, so far as practice has determined, the principal solution of the wet weather haulage problem. Its design and construction have been so far in the hands of earth moving contractors, who have considered it a temporary tool deserving no more attention than that necessary to get it through its period of service, or else in the hands of manufacturers who have had primarily the commercial viewpoint. Given a thorough engineering study trackways appear capable of a development which promises largely to overcome wet weather haulage delays in excavation.

While housing of excavation has been dismissed as generally impracticable there appear to be oportunities for its adoption. In trench excavation and in subgrading highways the possibilities of tenting over sections so as to eliminate largely the effects of summer showers and light rains appear to be large.

Road Building—Rain and mud delays are emphasized in road building for the following reasons: (1) Practice requires so close a finish on subgrade that a very light rain is sufficient to stop work; (2) there is heavy hauling for long distances over unimproved roads; (3) the fine surface required on concrete roads is easily marred, on fresh work, by rainfall.

Under these conditions, on practically every day there is rain, paved road construction is interrupted. This year in Pennsylvania, up to July 22, it had rained on 34 of 82 working days. In Iowa last year, about 15 per cent of the calendar days of the season worked were lost due to rain and mud. On 13 per cent of the days worked rain and mud caused delays in excess of 45 minutes. Time lost in road building because of rain and mud is, therefore, probably not much less than 15 per cent of the total working season. How can this lost time be curtailed? Investigations of the question seem promising in the following directions:

1. Determine whether engineering limitations on wet weather work cannot be safely enlarged so as to extend the boundaries of rain and mud conditions within which construction is approved.

2. Determine the possibilities of housing. (Canvas tents on timber frames which roll on the side forms are widely used to protect green concrete pavement from sunshine and rain. Could not the same arrangements be adopted to shelter finished subgrade? They would seem practicable with industrial railway haulage on road-side tracks.)

3. Determine the possibilities of water-proofing the subgrade to shed rainfall. (Crowned subgrades have been found helpful in shedding water. A sprinkling of road oil has been advocated and given a tentative trial.)

4. Determine the possibilities of blotting up the mud layer by sprinkling the subgrade with sand, stone chips or other dry material.

5. Determine whether and under what circumstances drying is practicable. (Driers made like those for drying brick pavement for bituminous filler or like the heaters used in repairing asphalt pavement and traveling on the forms like a finishing machine seem to offer possibilities.)

As in earth moving, hauling is the outstanding wet weather problem in road building: first, it is the controlling construction operation; second, it is the one operation which has most possibility of disturbing greatly a previously accomplished operation—subgrade maintenance is virtually at the mercy of hauling methods. Investigation of methods of hauling least affected by rain and mud surpasses in importance any other task. In character it is virtually the same as in earth moving: (1) developing machines for soft ground and mud operation and (2) developing trackways for vehicles and machines.

Generalization—From the facts brought out in discussing earth moving and road building two broad generalizations for construction as a whole are possible:

1. Plan construction operations for wet weather conditions. (In present practice these conditions are recognized in the shape of a percentage added to the cost of work to cover rain and mud delays. What should be done is to plan carefully to reduce the delays themselves.)

2. Develop equipment and methods which rain and mud will least interrupt. (So far what has been done is incidental. The results are erratic. Brought together and analyzed, however, some degree of correlation and generalization is practicable and from this a statement is possible of the lines of development to be pursued.)

Economic Problems—As in every other factor of the problem of lost time in construction, one is confronted in considering the loss due to rain and mud delays by a great lack of means of valuation. There are almost no figures. Even formulated thought appears to be lacking. Quantitative statements are possible only by information. The condition would be discouraging except that it indicates a brilliant opportunity for research of the most useful character.

In order to make some attempt to present the situation specifically let us consider road building; it is disturbed more than most work by rain and also it is the operation for which we have a few records.

It may be assumed that a day on which it rains is a lost day in road building. It is true that many of the rains will be showers which will not delay operations a full day; but there are enough other protracted or night rains which will prevent operations for a part or the whole of a following fair day to maintain the average of a day lost for every day on which there is any considerable rainfall.

Inquiry made of road contractors in practically every state east of the Mississippi between the Canadian boundary and the Mason and Dixon line indicates that one day a week of rain is a conservative estimate. This was about the average in Iowa in 1921, which was an excellent year for roadwork. This year in the east the average has been 2½ days a week. Assuming one day a week and a 25-week season production is curtailed one-sixth or 16⅔ miles for every 100-mile unit of a roadbuilding program.

These figures will probably not be equalled in any other kind of construction, but in all kinds there will be some decrease in output due to rain. What is the loss? Obviously it is of two sorts:

1. Loss by the contractor of the service of his organization, equipment and involved capital and

2. Loss by the owner of the services of the postponed structure.

What do these errors amount to in dollars and cents? Without precise figures we know that a loss of even 10 per cent in output in an industry whose product fetches three billion dollars a year is enough to warrant serious consideration. But precise figures are exactly what we must have. No proclamation of generalities will induce action. The following questions have to be answered specifically and quantitatively:

1. What percentage of the working season is wasted because of time lost because of rainfall and its consequences?

2. What is the loss, represented by delays in construction, caused by these delays due to rain?

3. What means are practicable of reducing delays due to rain and what amount will they add to the cost of construction?

The fourth article of this series, developing the problem of delays due to management, will appear in our next issue.

Oil-Engine Drive for Dipper Dredges

IN THE excavation of drainage ditches the use of machines operated by internal-combustion engines often has particular advantages in eliminating the trouble and expense which would be incurred in supplying and distributing coal for steam boilers. At the National Drainage Congress, held in Kansas City in September, the use of oil engines for dipper dredges was the subject of a paper by Geo. B. Massey, consulting engineer, Chicago, a summary of which follows:

In dredges operated by oil engines the engine may drive the machinery directly by means of clutches or it may drive an electric generator supplying current to motors for the different mechanisms. In the former case a belt drive is usually employed owing to the distance from the engine to the machinery. In the latter case there may be one main generator or a separate generator for each motor. Although this second arrangement is more expensive it uses less power since no resistances are required for control. In fact it is considered better than a steam engine in the relations of torque and speed. On a dipper dredge the oil-engine occupies the position of the boiler in a steam machine.

Most of the oil-engines used in this class of work are of the semi-Diesel type, and in the vertical engines the air for scavenging the cylinders is compressed usually in the crankcase to about 2 lb. pressure. A modified horizontal design has a separate compressing chamber, which arrangement permits of higher pressures. To start the engine, an electric heating coil is used or a torch to heat a plug in each cylinder head. With the straight Diesel engine the charge is ignited by the temperature due to high pressure of air in the cylinder.

In a two-cycle engine, firing a charge at each outward stroke, the piston acts as the inlet and exhaust valve, so that there are few moving parts. A four-cycle engine, with a charge fired at each alternate outward stroke, requires valves and camshafts. Most of the semi-Diesel engines are governed by regulating the oil charge according to the load. They have to be started usually by air at 150 to 175 lb. pressure, so that an air compressor must be attached to the main engine or driven by a small independent engine.

A little water in the cylinder permits of higher compression and increases the fuel economy, but it should not be used if the oil is high in sulphur as the combination of sulphur and water is destructive to the cylinder walls and piston rings. Some engine builders stipulate that the oil used shall contain not more than 0.5 per cent sulphur. Oil companies have special brands of oil suitable for internal combustion engines and engine builders recommend the use of oils meeting certain specifications. The heavier the oil, the lower the price and the greater the B.t.u. Using a heavy oil in summer and a light oil in winter obviates the necessity of installing a heater to warm the heavy oil so that it will flow readily.

Capacity of Panama Canal Ample for at Least 30 Years

Dimensions of Locks, Operating Efficiency, and Water Supply Will Suffice for Estimated Traffic—Difficulties of Sea-Level Proposal

By J. K. Baxter
Bureau of Statistics, the Panama Canal,
Balboa Heights, C. Z.

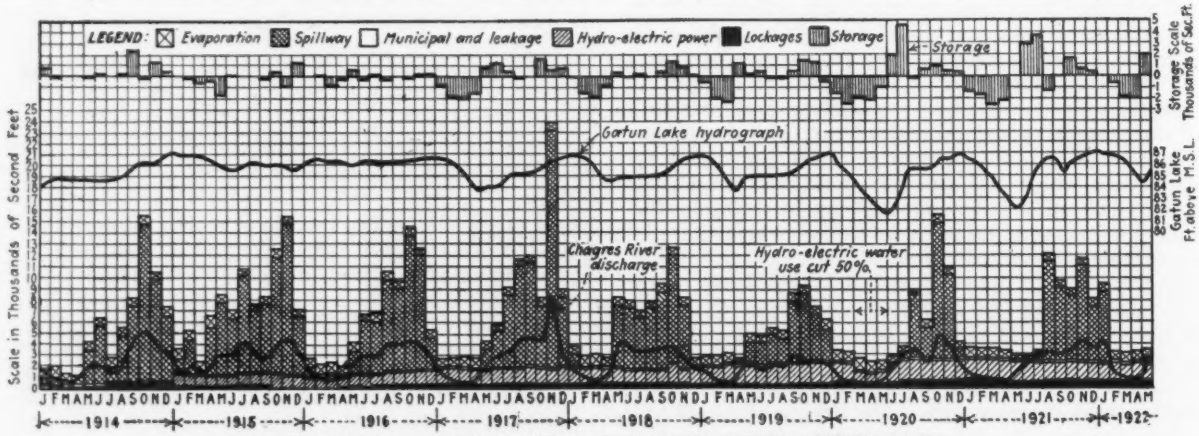
THE success of the Panama Canal has been so complete that the critics, who attacked almost every feature of the project between 1904 and 1915 and prophesied disaster unless radical changes were made in the accepted plans, have lapsed into silence. That the canal has been in successful and uninterrupted operation since the removal of the last great slides in 1916, and affords a safe and rapid means of communication between the two oceans is obvious and indisputable. Pessimists who still cling to the conviction that all is not well at Panama are forced to abandon the immediate present and postpone disaster to a problematical future. For the time being, they admit, the canal is serving its purpose, but its capacity, they say, is so limited that within a few decades at the most it will be outgrown and inadequate. For instance, one writer argues that not more than 50,000,000 net tons of shipping a year can be passed through the locks, and that the water supply will suffice for only 30,000,000 tons, while on the other hand there is every reason to expect a traffic of between 50,000,000 and 100,000,000 tons toward the middle of the century. The remedy usually suggested is that the present high-level lock canal be brought down to sea-level by gradual dredging.

It is perfectly true, of course, that the operation of the locks and the available water supply impose definite limits on the present canal. In the following paragraphs an attempt is made to estimate with reasonable accuracy what those limits are and how soon they may be reached.

Factors Limiting Capacity—There are three factors which may limit the usefulness of the present lock canal: (1) The number and dimensions of the locks; (2) The operating efficiency of the locks; (3) The water supply available for lockages, development of electric power, and maintenance of the water level of Gatun Lake.

Lock Dimensions—The locks have a length of 1,000 ft., a width of 110 ft., and a minimum depth over the sills of 42½ ft. For commercial vessels these dimensions are more than ample, and there is no present reason to suppose that they will not meet all the requirements of commerce for many years to come. There can scarcely be the same certainty in the case of battleships. The beam of these vessels has been increasing very rapidly, and in the most recently designed ships exceeds 100 ft. To meet the possible needs of the navy the construction of a third set of locks with a width of 135 ft. has been contemplated. There are foundations available for these new locks, if it is decided to build them.

Operating Efficiency of Locks—The estimated maximum capacity of the existing locks, with both flights in use, under ordinary service conditions, is 48 lockages per 24-hr. day. This would mean more than 48 ships, as the smaller vessels can frequently be locked through in tandem, and the possible occasions for doubling up in this manner will increase with the growth of traffic. Allowing only 3,500 net tons of shipping for each lockage, this would be equivalent to a maximum of more than 60,000,000 tons per annum, which may be cut to 50,000,000 tons to allow for the periodical unwatering of one flight of locks for painting and repairs. If a third flight of locks is built, the capacity of the canal will be correspondingly increased, assuming, of course, a sufficient supply of water.

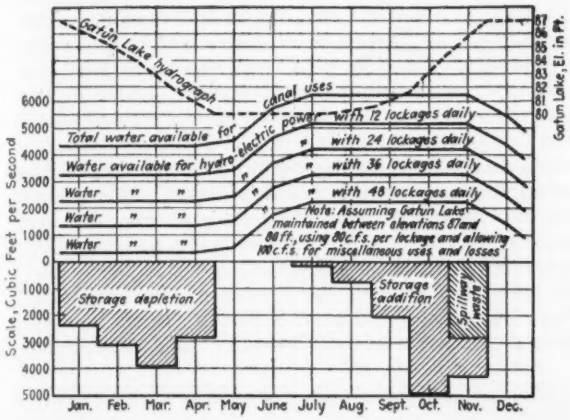

LEGEND: Evaporation Spillway Municipal and leakage Hydro-electric power Lockages Storage
Storage
Gatun Lake hydrograph
Chagres River discharge
Hydro-electric water use cut 50%
Scale in Thousands of Second Feet
Storage Scale Thousands of Sq. Ft.
Gatun Lake Ft. above M.S.L.
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M
1914 1915 1916 1917 1918 1919 1920 1921 1922
DISPOSITION OF GATUN LAKE WATER SUPPLY FROM 1914 TO DATE

Water Supply—The water supply available to maintain the summit level of a lock canal has been the subject of careful and continuous study from the days of the French canal company to the present time, and fresh calculations have been made whenever new elements were introduced which affected the problem.

During the rainy season there is a surplus of water flowing into Gatun Lake, which under present conditions is wasted over the spillway. But during the dry season, which is normally less than four months long, but may extend to six months in exceptional years, the inflow is slight, and the canal is partially dependent on

water stored during the wet months. The Gatun Lake is the only present storage basin. It is filled to a height of 87 ft. above sea-level at the close of the rainy season, and can be drained to 80 ft. during the dry season without interference with navigation. The storage capacity of the lake between the two levels is 31.8 billion cu.ft. This is sufficient for all present needs, including the operation of the hydro-electric plant at Gatun, but if in an extremely dry season it becomes necessary to economize water, a part of the power load can be transferred to the steam plant at Miraflores, which is maintained in reserve to meet this and other emergencies.

All plans for a lock canal, however, have contemplated


Gatun Lake hydrograph
canal uses
Total water available for
hydro-electric power
with 12 lockages daily
with 24 lockages daily
with 36 lockages daily
with 48 lockages daily
Water
Note: Assuming Gatun Lake maintained between elevations 87 and 80 ft., using 80 c.f.s. per lockage and allowing 100 c.f.s. for miscellaneous uses and losses
Storage depletion
Storage addition
Spillway waste
Scale, Cubic Feet per Second
Gatun Lake, El. in Ft.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

AVAILABLE WATER SUPPLY FOR CANAL USES WITH PRESENT STORAGE

Based on average net yield of 10-year period, 1911-1920

the need for additional water storage, to be provided by the construction of a dam across the valley of the Chagres River at Alhajuela, ten miles above Gamboa where the river now enters the lake. This is an important feature of the ultimate scheme. It is estimated that the Alhajuela Dam will impound 15 billion cu.ft. of water, which can be drawn upon to maintain the level of the Gatun Lake during the dry season. If further storage becomes necessary there are excellent reservoir sites in the valley of the Chagres and its tributaries above and below the proposed dam. The installation of a hydro-electric plant at Alhajuela is also contemplated. Water used there to generate power would flow into the Gatun Lake and still be available for the operation of the locks.

The following tables show the actual inflow of water into the Gatun Lake and the usage of water during the calendar year 1920, the driest on record since the lake was formed:

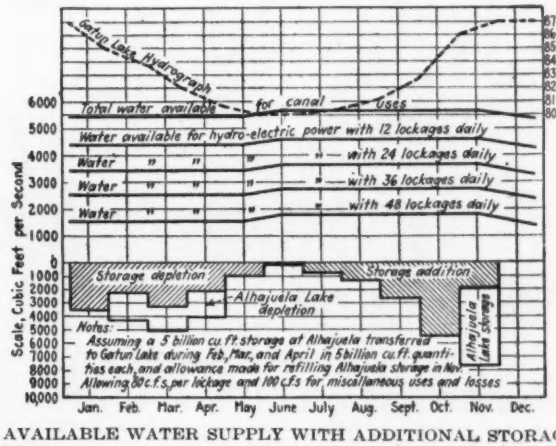
Inflow into Gatun Lake	Per Cent	Billions of Cu.Ft.
Run-off above Alhajuela	38	65.21
Yield from land area below Alhajuela	44	74.95
Direct rainfall on Gatun Lake	18	31.38
Total	100	171.54
Use or Disposition		
Evaporation from lake	13	22.40
Lockages	12	20.87
Hydro-electric power	26	44.42
Spillway discharge	47	81.00
Leakage and municipal water	1.5	2.45
Increased storage	0.5	0.40
Total	100	171.54

It will be noted that 47 per cent of the total inflow was wasted over the spillway, only 12 per cent was used for lockages, and 26 per cent for hydro-electric power. During the year in question 10,000,000 tons of shipping passed through the canal.

The most important present draft on the water supply is for the generation of electric power. The use of water from Gatun Lake for that purpose is convenient and economical, but it is not essential. It will be continued so long as and to the extent that water is available; but in case of shortage the load can be transferred in whole or in part to a hydro-electric plant at Alhajuela or to the steam plant at Miraflores.

The latest studies indicate that during the driest 12-month period of record (July 1, 1919, to June 30, 1920) the water available during the dry season would have sufficed under existing conditions for 30 lockages a day, provided none was used for power, or for either 24 or 12 lockages a day with operation of the Gatun hydro-electric plant at 14 or 45 per cent of its full capacity.

Under the same conditions of minimum dry-season inflow, but with the Alhajuela Lake to draw upon for


Gatun Lake Hydrograph
Total water available for canal uses
Water available for hydro-electric power with 12 lockages daily
with 24 lockages daily
with 36 lockages daily
with 48 lockages daily
Storage depletion
Storage addition
Alhajuela Lake depletion
Alhajuela Lake Storage
Notes:
Assuming a 5 billion cu.ft. storage at Alhajuela transferred to Gatun Lake during Feb., Mar., and April in 5 billion cu.ft. quantities each, and allowance made for refilling Alhajuela storage in Nov.
Allowing 80 c.f.s. per lockage and 100 c.f.s. for miscellaneous uses and losses
Scale, Cubic Feet per Second
Gatun Lake El. in Ft.
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec.

AVAILABLE WATER SUPPLY WITH ADDITIONAL STORAGE AT ALHAJUELA

Based on average net yield of 10-year period, 1911-1920, with 15 billion cu.ft. additional storage when Alhajuela Dam has been built.

additional water supply, it would be possible to make 56 lockages a day, provided the hydro-electric plant were closed down.

During an average year after the construction of the Alhajuela Dam it will be possible to make 24 lockages a day throughout the dry season while operating the hydro-electric plant at Gatun at full capacity, or 48 lockages a day with the hydro-electric plant running at 46 per cent capacity.

There is no reason to expect that the water supply will not be sufficient for 48 lockages a day, equivalent to not less than 50,000,000 tons of shipping per annum, even under the most unfavorable conditions of inflow, provided the plans for additional storage are carried out, and a reserve power plant is maintained capable of taking the load off the Gatun station for extended intervals. This is a conservative estimate, and it is probable that the water supply, if intelligently conserved, will suffice for a much heavier traffic. At any rate, the limiting factor, after the construction of the Alhajuela Dam, will be the operating capacity of the locks rather than the water supply.

Estimated Future Traffic—Assuming that not more than 50,000,000 tons of shipping can be passed through the present locks in one year, it remains to be considered how soon the traffic will attain to that volume.

This cannot be accurately determined. Any forecast of what the traffic will be thirty, twenty, or even ten years hence can be little more than a guess.

Prior to the opening of the canal Prof. Emory R. Johnson undertook an exhaustive study to determine what traffic would be available in 1915 and what rate of increase might reasonably be expected during the first decade of operation. His conclusions were published in a report on "Panama Canal Traffic and Tolls" submitted to the Secretary of War in 1912. He estimated that starting from 1900 the increase in the traffic which might use the canal had been at the rate of 60 per cent per decade, that the rate of increase after the canal was opened could only be conjectured, but that an

CLOSE-UP OF 1916 SLIDE IN GAILLARD CUT
A sea-level canal would require this cut to be dredged 90 ft. deeper, thereby causing further slides of far-reaching extent. This 1916 slide is now at rest.

assumption of an increase of 60 per cent between 1915 and 1925 would be conservative.

The following table shows the annual traffic through the Suez Canal in thousands of tons at 10-year intervals from 1870 to 1920:

Year	Thousands of Net Tons	Increase per Decade
1870	436	...
1880	3,057	
1890	6,890	126 %
1900	9,738	43 %
1910	16,581	70 %
1920	17,574	6 %

The Suez Canal traffic increased very slowly during the first five years of operation, as the canal could not be used to advantage by sailing vessels, and did not come into its own until steam had definitely superseded sails. The decade from 1890 to 1900 was a period of general business depression, which is reflected in the statistics. In the decade from 1910 to 1920 normal development was interrupted by the war, and a considerable volume of traffic was diverted from Suez to Panama.

The following figures showing the increase of the world's tonnage over a period of 37 years are quoted from the Encyclopedia Britannica:

	1873	1890	1900	1910
World's tonnage (thousands of tons)	17,545	22,151	29,043	41,914
Increase on the basis of 1873 as 100	100	126	165	240
Average rate of increase per annum (per cent)	....	1.5	2.4	3.8

The records of the Panama Canal itself during the first seven fiscal years of operation probably do not afford a reliable index of future growth. The opening of the canal coincided with the outbreak of the war in Europe. The traffic of the first few years was adversely affected by the war, and the subsequent increases do not represent normal growth so much as the transition from war to peace conditions. Expressed in thousands of net tons the traffic of the Panama Canal has been:

1915	3,792	1919	6,124
1916	2,396	1920	8,546
1917	5,798	1921	11,415
1918	6,574	1922	*

*Note: Accurate figures for 1922 are not yet available, but the tonnage will be approximately the same as in 1921.

W. L. Hersch, electrical engineer of the Panama Canal, in a study completed in December, 1920, attempted to base a forecast of future traffic on these past records. Disregarding the first two years as abnormal, he concluded the number of vessels per month was increasing by arithmetical progression at the rate of 32 in a period of one year. Starting with 1,800 vessels in 1917, this would give 5,640 in 1927, 9,480 in 1937, 13,320 in 1947 and 17,160 in 1957. The increase during the first decade would be at the rate of 213 per cent, during the second decade 68 per cent, during the third decade 40 per cent, and during the fourth decade 28 per cent. This assumption of a very high rate of increase during the early years of operation declining gradually and constantly thereafter can not be reconciled with the Suez record nor with the record of the growth of the world's tonnage; but extended over a period of thirty or forty years it yields the same ultimate result as the assump-

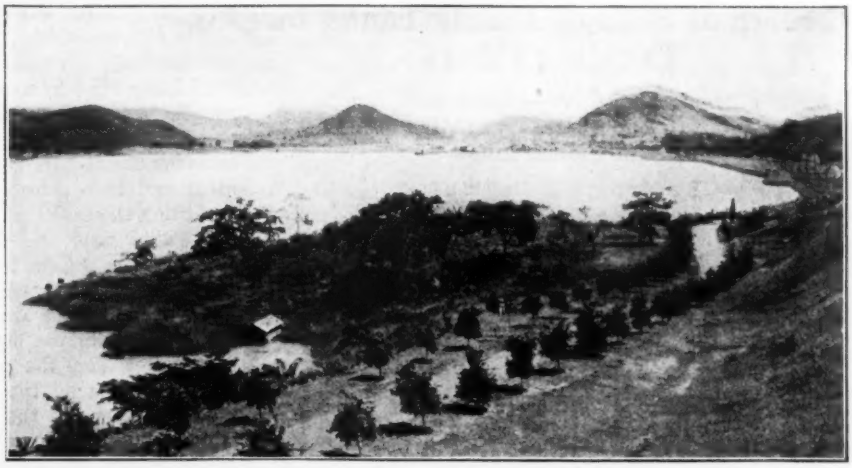
SLIDE NORTH OF GOLD HILL IN 1915
This view shows the canal channel practically closed and indicates the difficulties that would attend the excavation of the canal to a grade 90 ft. lower.

tion that traffic will increase at a uniform rate of 60 per cent per decade. With either method of calculation the date on which the traffic will aggregate 50,000,000 net tons per annum falls within the decade between 1950 and 1960.

Period of Ultimate Capacity—A careful consideration of these facts and probabilities indicates that the demands for the immediate enlargement of the canal are premature. The present waterway ought to suffice for at least thirty years. It is conceivable, however, that at some time between 1950 and 1960 the traffic may pass the 50,000,000-ton mark, and that the canal will then approach the limit of its capacity. Given an era of unprecedented commercial expansion, this point may be reached at an even earlier date, or under adverse conditions it may be indefinitely deferred. That will be much clearer in 1930 or in 1940 than it is now, and

ample time will still remain to provide the improved facilities which may be needed.

The Sea-level Project—The favorite proposal of the critics of the present waterway is that it be converted by gradual dredging to a sea-level canal. The project is advocated by Lt.-Col. Bunau-Varilla, who submitted it to the International Board of Consulting Engineers in 1906, and has brought it forward on numerous occasions since. The only sea-level canal ever seriously considered, that recommended by the majority of the International Board, had a bottom width for 21 miles of only 150 ft., and for 19 miles of 200 ft., as compared with the minimum width of 300 ft. in the present Culebra Cut. It gave tortuous navigation through a comparatively narrow gorge in which large vessels could not proceed under full headway or pass without risk. The capacity of such a canal would scarcely be greater and might well prove less than that of a lock canal. No one would argue that the proposed dimensions would meet present requirements, and still less the requirements of the future. If a bottom width is assumed that would justify the appellation of "The Straits of Panama," a phrase that has been applied to an ideal and wholly imaginary sea-level canal, the cost of the work will be enormously increased. The amount of excavation that might be required through the continental divide can not be estimated with any degree of accuracy. In 1906 it was believed that the banks through this sector would stand at a relatively steep angle. Experience has shown that this is not true, and that no given slope can be predicted. But it may be regarded as certain that slides of the most serious nature will develop, if the present excavation is carried 90 ft. deeper. There remains the problem of controlling the Chagres River and the other streams which now flow innocuously into the Gatun Lake.



MIRAFLORES LAKE

If the canal should be deepened to sea-level to create a "Strait of Panama" this lake would become a ditch 70 ft. deep.

The undertaking bristles with difficulties, and it has never gained the support of any American engineer who has served on the Isthmus and is familiar with local conditions. Nothing in the present situation justifies this questionable improvement, and if some thirty years hence it becomes necessary to provide for the passage of a greater number of ships than the present lock canal can handle, it is probable that even then this sea-level project will be rejected for some more economical alternative.

CUCARACHA SLIDE IN 1920

This view, taken from north of Contractor's Hill, gives a further indication as to the task involved in lowering the grade to sea-level.

Improvements for South Manchuria Railway

For the fiscal year ending March 31, 1923, the South Manchuria Ry. has appropriated $4,061,910 to be devoted to railway improvements and construction, according to recent information from the company. The double-tracking of the line with 100-lb. rails between Tiehling of Chungku, between Chuantu and Shwangmiaotze, and between Wuchiatun and Suchiatun will be continued, and the type of rails used in the Dairen wharf inclosure will be changed. At Mukden station a roofed-in passenger platform will be constructed and additional sheeting will be purchased to protect against moisture in connection with the equipment for mixed storage of beans. On the line between Mukden and Suchiatun, an automatic signal system will be installed. The building of additional freight locomotives, reconstruction of rolling stock of all types, and the finishing of nine freight locomotives and twenty freight cars begun during the previous fiscal year are the other items included in program.—*Commerce Reports.*

Design of Sewage Dosing Tanks for Trickling Filters

Basic Efficiency Features—Shape and Dimensions —Intermittent Operation at All Flows— The Siphon Inflow

By Edmund B. Besselievre
Sanitary Engineer, New York City

DOSING tanks for trickling filters, while one of the most important units in a sewage treatment plant which employs that type of filter, are not usually given the amount of study that their important function deserves. Information on the factors entering into the proper design of dosing tanks, and on the proper value to be given these factors when actually designing a tank to fulfill certain known conditions, is meagre and in the past a great many engineers have depended upon the manufacturers of siphons for the design. This dependence upon the manufacturer of equipment has in general worked well in procuring proper co-relation between the tank and the filter, but the writer believes that it would be well for every engineer to be able to study this problem himself and design for himself a proper tank. The object of this article is to summarize experience covering a period of fourteen years, during which time the writer has designed or redesigned many dosing tanks, and witnessed a great many of the common errors in design which tend to nullify the results desired from the tank.

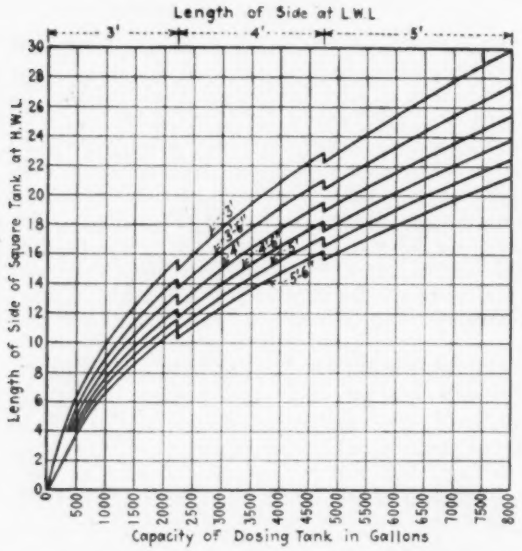


FIG. 1—DIAGRAM FOR DESIGNING SEWAGE-DOSING TANKS WITH VARIOUS DEPTHS OF SEWAGE

Computed from formula, $Q = 7.5\ [h/3\ (A + \sqrt{Aa} + a)]$, where A = top area of tank; a = low-water level; h = distance between high-water and low-water levels.

A recent article on this general subject by E. E. Sands, consulting engineer, Houston, Texas ("Hydraulics of Dosing Tanks and Trickling Filters," *Engineering News-Record*, July 13, 1922) added materially to the literature on the subject by outlining the hydraulics involved in the computation of size of dosing tanks and filters; but certain basic features were not covered in that article and must be given full weight and consideration to enable any tank to function efficiently. It is the writer's object to present these herein.

The Primary Object of a Dosing Tank is to discharge automatically a measured dose of settled sewage upon a trickling filter in such a manner as to insure that each square foot of the filter surface will receive the same quantity of sewage at all heads in the tank. Let us consider the factors entering into this ideal accomplishment and then show how each must be considered in designing the tank.

There must be determined (1) the amount of sewage to be treated per day; (2) the area of the filter to give efficient treatment to that amount of sewage; (3) the total head available between the invert of the discharge from the settling tank to the invert of the final outlet from the treatment plant; (4) the spacing of the nozzles on the filter and the determination of size of nozzle; (5) the dosing cycle or length of time it is desired that the nozzles shall be in play; (6) the depth of the filter; (7) the size of the dosing tank; (8) the size of the dosing siphon.

Mr. Sands, in his article, has covered the hydraulics of the various elements very well. His data will not be repeated.

Although experimentation and practice have shown that it is impracticable to procure perfect distribution over a trickling filter at all heads, the results obtained with a type of dosing tank that is easily designed and built are sufficiently satisfactory to make unwarranted attempts to secure better results by complicated structures.

The tank giving perfect distribution is one in which the area of the tank decreases as the bottom is neared. For perfect results, the tank would be in the shape of an inverted pyramid with sides of a parabolic form. In practice it has been proven that a tank in the shape of a four-sided inverted pyramid, or to be correct, frustum of a pyramid, with sides sloping straight downward from the high-water level to the low-water level, is sufficiently accurate to be generally adopted.

Size of Tank—Having determined the volume of sewage and the length of dosing cycle, the first consideration in dosing tank design will be the volume of the tank. Knowing the discharge capacity of each nozzle at the average head and the number of nozzles and the length of dosing, we can easily arrive at a figure which will represent the total volume to be discharged. This represents the largest part of the dosing tank contents. Unless twin dosing tanks are used, in which the inflow is shut off at the instant of commencement of discharge, the inflow of sewage into the dosing tank during the discharge period must be considered. As it is desirable that the tank be sufficient to operate at the maximum flow, the inflow rate must be considered on the maximum basis for the period of discharge.

Here is where the average designer stops and fails to allow for the most important element. All plants or plans that the writer has seen provide for nozzles spraying to a predetermined radius from the nozzle but in very few cases is that condition reached in practice. Why? For the simple reason that between the dosing tank and trickling filter distribution system, there is a system of piping, beginning with the siphon in the dosing tank and continuing in the main distributors and laterals in the beds and the risers to the nozzles and a certain portion of this piping must be above the tops of the nozzles. After the siphon has stopped discharging, all the water remaining in that portion of this connect-

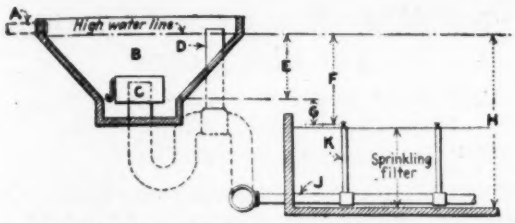


FIG. 2—PRINCIPAL ELEMENTS OF DOSING TANK DESIGN
A = Inlet. B = Dosing tank. C = Automatic siphon. D = Vent and overflow. E = Depth of tank or effective dosing head. F = Minimum head on nozzles. H = Total available head. J = Distributing pipes. K = Risers to nozzles.

ing link which is above the nozzles will drain out through the nozzles. What has that to do with distribution, it is asked?

The most effective head, that which will produce the widest radius of spray, is naturally the high-water line in the dosing tank or the point at which the siphon comes into operation. Therefore, if the plant is of considerable size, the pipes between the siphon and the filter will be large and, if a short cycle of dose is used, the dosing tank will be small. Consequently whatever length of pipe is above the nozzles must be filled with sewage before any sewage will be forced from the nozzles and this sewage comes from the first flush of the siphon and consequently is taken from the highest and most effective head, so that instead of this valuable pressure being distributed in the form of widely flung spray, it is wasted by filling up a pipe.

The writer has seen several plants wherein failure to consider this has caused most ineffective distribution and a very small wetted area on the filter. In one instance, on a large plant, the nozzles did not cover a radius of more than 3 ft. and in another, not only was distribution poor but the air in the pipes being forced out through the nozzles rivalled the best steam calliope any circus ever had.

The remedy for this trouble and waste of effective head is easy to employ and consists in (1) so designing the distribution pipes that the smallest possible amount is higher than the lowest nozzle on the beds and (2) providing dosing tank capacity for filling the pipe at the high heads.

It is a simple matter, after having determined the size of the dosing tank, to compute the capacity of the piping that will be emptied at each discharge and if this piping is laid out properly, it will then be a simple matter to add to the height of water in the dosing tank the few inches which will give the volume of water desired. In properly designed plants the writer has found in a large number of cases that this extra head seldom amounts to more than 2 or 3 inches.

Tank Depth—Now we have the three elements entering into the volume of water or sewage to be held in the tank. Next we must consider the depth of the tank. Usually the depth of the filter is determined by the engineer from his experience or by reference to data on successful plants. Subtracting this depth from the total available head we have the balance available for dosing tank. However, before deciding the depth of the tank we must allow for that head which is necessary to overcome friction in the distributing system and which will give a small spray. This head varies in each case, but reference to the catalogs of siphon manufacturers will show that the minimum between the nozzle head and the low-water line in the dosing tank is about 1 to 1½ ft., depending upon the size of the siphon, pipes, etc. Assuming it to be 18 in., this must be added to the depth of filter and deducted from the total available head. The remainder is the total allowable depth of dosing tank from the high-water line or the point at which the siphon starts to low-water line or point at which the siphon stops.

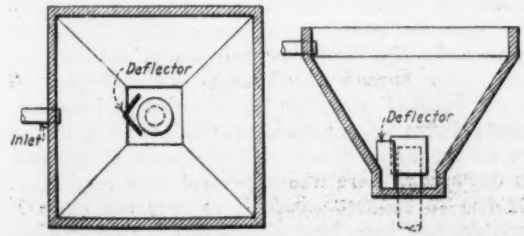


FIG. 3—INFLOW DEFLECTOR FOR DOSING TANKS

To facilitate the computation of dosing tanks the writer has devised a chart (Fig. 1) which will enable any engineer, after having determined the total volume of the tank as given above, to lay out a tapered tank of the proper size. This chart shows at the bottom the capacity of the tank in gallons. The curves indicate different depths of tanks. At the left side is given the length in feet of each side of a square-topped tank and at the top is shown the length in feet of the side at the bottom of the tank or the small area of the frustum of the pyramid. To select the proper tank is a simple matter. Having the volume, go straight up the chart to the line representing the depth of the water in the filled tank, then straight to the left from that point will give the length of the top of each side of the tank. Straight up from the volume to the top of the chart will give the length of each side of the bottom of the tank. This length is the minimum that will give the desired results. In large tanks the length of the sides of the bottom may be made as long as seems most advisable consistent with the length of the sides at the top of the tank and the slope of the sides of the tank, which should approximate an angle of 45 degrees wherever practicable.

The reason for including the length of the side at the low-water line is an important one. In order to empty a dosing tank there is usually provided an automatic dosing siphon. This siphon is located in the center of the tank in most cases and the part of the siphon visible in the tank is a large cast-iron dome or "bell." The low-water line in the tank is the invert of a small vent pipe on the outside of this bell, and in order to avoid a large amount of sewage being allowed to remain in the tank, the tank is usually constructed as an inverted frustum of a pyramid, superimposed upon a rectangular section with an area equal to that of the small area of the pyramid and a depth equal to the distance between the low-water line and the bottom of the siphon bell, plus the clearance called for between the bottom edge of bell and floor by the siphon manufacturer. Fig. 2 shown here illustrates this construction.

Having determined the size of tank and the size of siphon to discharge it in the allotted time, the size of siphon bell will be known and it is wise always to make the bottom of the pyramid larger by at least 12 in. than the diameter of the siphon bell. Thus with a siphon bell 30 in. in diameter, the length of side of tank at low-water level would be at least 42 inches.

Another important function of the dosing tank is that it operate intermittently at all flows. Therefore to

secure this, it is necessary to install a siphon capable of discharging at the low head close to the low-water line more water than is flowing into the tank at maximum flow rates. If too small a siphon is installed, at times of high flows the filter will go into continuous operation, which may result in flooding and negative bacterial action and this will continue until the high flow recedes. Careful use of the tables furnished by the siphon manufacturers will help to avoid this error.

Siphon Inflow—One other point that is of prime importance in procuring the maximum efficiency from the dosing siphon is the placement of the siphon as regards the inflow. In most tanks it is usual to bring the influent pipe in at the top of one side and allow the sewage to flow down that side. When the tank is empty the velocity of the flow toward the bottom will be very high. In several large plants this water rushing down and under the bell of the siphon has seriously interfered with the operation of the siphon by withdrawing some of the air from the bell. In order to have the siphon start operation at the same elevation each time it is necessary that the air conditions in the bell be the same after each discharge and this rush of water under the bell is very apt to draw out some of the air, varying in quantity with the volume and velocity of the water, thus introducing an element of uncertainty as to the high-water line. In one large plant it was necessary to place a wing-shaped deflector around the bell on the side from which the water came so as to divert the water to the sides of the bell. This is a simple matter (Fig. 3) and in a large plant with great volumes and high velocities, will eliminate one more cause of possible trouble. The writer has always deemed it wise to include some modification of this device in all large tanks.

In several large plants designed within the last few years, it has been desired to attain definitely measured doses of sewage upon the bed regardless of the rate of inflow to the plant. This has been accomplished by the use of two dosing tanks of identical size, shape and volume, each equipped with a siphon for emptying and also with an air-lock feed through which the inflow comes. When the water level in either of the tanks is reached, the air-lock feed, which is operated by an air bell in a subsidiary chamber, stops the flow of water through the feed of the filled tank and at the same time opens the feed of the second tank and starts the discharge siphon of the filled tank. This cycle goes on continuously, each tank discharging exactly the same amount of sewage at each discharge, the only difference being that the tanks take longer to fill at low rates of flow. Sets of these tanks are in operation at the sewage-works of Lexington, Ky., and Mansfield, Ohio.

The writer believes that the information given will prove of value to those engineers who are called upon to design sewage dosing tanks and he knows that if the special considerations of design are carefully studied whenever such a case arises, there will be no more of the regrettable failures in proper distribution.

More and Better Maps Demanded

The need for accurate topographical maps in connection with highway construction and for those engaged in the petroleum industry has added greatly to the public demand for more and better maps, it was brought out at a recent meeting of the Federal Board of Surveys and Maps. It was announced that so far as the topographic maps published by the Geological Survey are concerned no change in scale will be recommended.

Pavement "Explosions" Continue For Five Years

Portions of Surface Violently Break Away From Concrete Base—Thirty-Three Upheavals in Five Years

CONTINUED failures of a paved road by the violent parting, with mutual shattering, of the brick surface and the concrete base, has become of increasing concern to the highway officials of King County, Washington, in which the city of Seattle is located. The breaks, besides being a constant expense to repair, have been on occasions so violent that passing vehicles have been injured and in one instance, which will later be more fully noticed, the "explosion" was the basis of a successful suit for damages in a large amount. In all

VIEW OF EXPLOSION AREA IN PAVED ROAD IN KING COUNTY, WASHINGTON

The bricks which were scattered by the explosion have been replaced approximately in their original position. This explosion wrecked a passing motor truck.

33 breaks have occurred since the first, on June 13, 1917, a few months after the completion of the pavement.

A description of the pavement construction was published in *Engineering News-Record*, April 19, 1917, p. 131. From this description it appears that the pavement consists of a 1:3:6 concrete base, 3 in. thick at the edges and 5½ in. at the center. On this base 3½ x 4 x 8½ in. paving brick were laid flat and bonded to the base by a 1:3 dry mortar cushion in which their bases were embedded immediately after the concrete was poured. The filler between the bricks was a 1:1 cement grout spread with brushes and squeegees. The roadway is 20 ft. wide and for much of its length is on grades ranging up to a maximum of 4.6 per cent. There were no expansion joints. In the base, at the end of each day's run, there was a beveled construction joint.

Of the 33 failures which have occurred since 1917 more than half have been violent and are referred to as "explosions." In case warning is given in the form of

a crushing of the bricks or a slight upward bulging, endeavor is made to prevent the more complete rupture by putting maintenance crews at work immediately, cutting the pavement at the point where the excess stress is manifest and substituting an 8-in. strip of asphaltic compound for two transverse rows of bricks. More often, however, the upheaval comes without warning and as much as 200 sq.ft. of the surface has been suddenly thrown from the base and shattered as though from an explosion. In some instances the base has been broken by the shock. In a damage suit growing out of an explosion, witnesses testified on the stand that pieces were thrown 30 to 40 ft. high in the air. Fragments are said to have been found 80 to 100 ft. from breaks.

A study of the location of the breaks does not show anything in common on this score. They occur on fills and in cuts, on the north, as well as the south slopes of hills, on the tops of gravel benches and in wet flats. On some parts of the road a number of breaks have occurred close together and in other stretches of considerable length there have been no breaks whatever. In the comparatively short section where expansion joints ½ in. wide were used in the brick, but without any joint in the concrete base, breaks occurred the same as in the other sections. In sections where new bricks have been relaid after a break, using the same form of construction as the original pavement, breaks have occurred a second time in the same spot. It is notable, however, that no breaks have recurred where the relaid pavement has been provided with the 8-in. asphaltic expansion joint referred to previously. This type of joint has now become standard practice when breaks are repaired. It extends through the concrete base as well as through the brick surfacing.

Some of the earlier failures and their possible causes were described and discussed in *Engineering News-Record*, Aug. 16, 1917, p. 319. There it was mentioned, the passing of trucks or cars over the weak spot appeared to "set off" the explosion. This fact is to be noted in connection with the accident that, as previously noted, caused legal complications.

On June 20, 1920, a truck driving over the pavement was wrecked by a violent upheaval of the surface beneath it. Such was the force that flying fragments smashed the running gear, brought the truck to a sudden stop and caused those riding on the driver's seat to be thrown to the pavement. A suit brought against King County on account of injury sustained in this accident secured a judgment from the Superior Court of King County in June, 1921, for $10,000 damages. The case was appealed to the Supreme Court of the state, which court on March 4, 1922, affirmed the judgment of the lower court. A petition for rehearing, filed by the county, is still pending.

The case did not bring out the causes of the upheaval from the engineering point of view, but rather showed that (1) the county knew the road was subject to these upheavals but (2) despite that had not succeeded in "maintaining the road in a safe and satisfactory condition" as required by statute.

Rail Earnings for August at Low Ebb

According to reports filed by the carriers with the Interstate Commerce Commission the net operating income of the Class I railroads of the United States totaled $52,579,799 in August. This represented a return of only 2.65 per cent annually on their tentative valuation.

Boldly Designed Center for Heavy Concrete Arch

Steel Viaduct Practice Applied to Timber Falsework —Settlement Under Load Less Than an Inch—No Wedges Used

A CENTERING so slender that its failure was freely predicted has recently been taken from under the successfully completed arch ribs of the Beechwood Avenue Bridge in Pittsburgh, Pa. This bridge has a clear span of 279 ft., and the two ribs with their connecting struts, which the centers had to carry, contained about 1,500 cu.yd. or, say, 3,000 tons of concrete. Four timber towers, with four legs each, carried the load during construction and the sixteen 20-in. square posts of these towers were virtually the only supports during the 2½ months while the arch ribs were being concreted. They extended upward 65 ft. unbroken by joints and there were, in fact, only four bearing surfaces from the footing to the lagging, which explains the total deflection under load of only ¾ in.

FIG. 1. CONSTRUCTION TRESTLE, CENTERING AND CHUTING PLANT

A description of the main structural characteristics of the Beechwood Avenue Bridge was published in *Engineering News-Record*, Jan. 5, 1922, p. 29, where also the principal dimensions were stated. Briefly the arch ribs are 8 ft. wide and 10 ft. deep at the springing lines tapering to 6½ ft. at the crown. The intradosal rise is 55.89 ft. Each rib is reinforced with a structural steel rib of eight 6 x 4 x ⅜-in. angles and 2⅞ x ⅜-in. bars. Each rib was concreted in nine sections, a crown section of 70 ft. and eight 30-ft. sections, with 3½-ft. key sections between them. Concreting the two arch ribs and eight cross struts was begun April 24 and with the exception of the key sections was completed on May 3. It took five days to ream and bolt the structural reinforcement in the key spaces and two more days to concrete the key sections, thus completing the ribs and struts on May 10.

Only two unusual features call for especial attention: (1) the trestle for the traveler which erected the centering, forms and reinforcement and (2) the falsework and centering. The view Fig. 1 shows the complete outfit, the trestle and traveler in the foreground and, behind the trestle, the falsework, centering and arch-rib forms. It will be noted that the trestle was carried

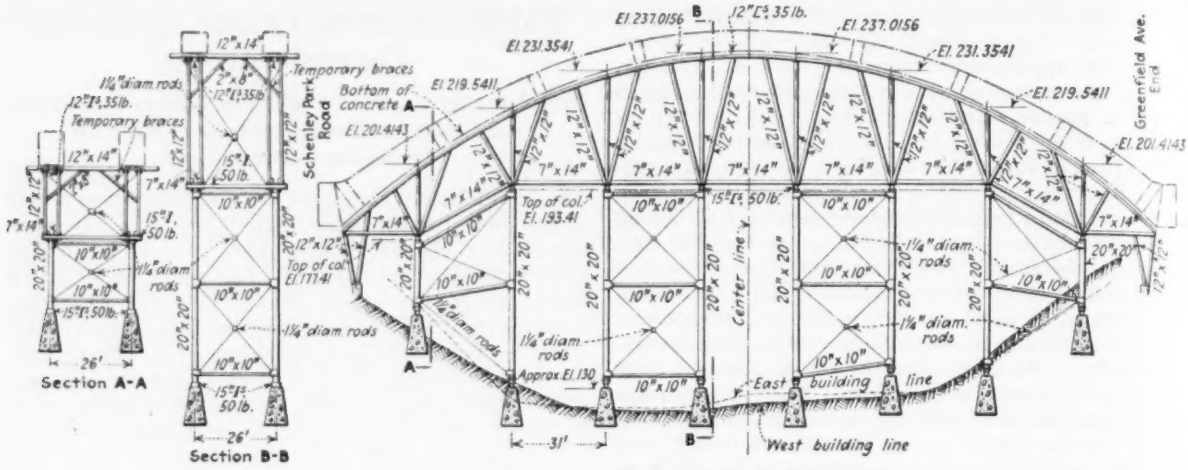


FIG. 2. FALSEWORK AND CENTERING FOR TWO-RIB ARCH

out from one bank only far enough for tne derrick to reach the opposite abutment This gave a stub-end structure about 145 ft. high at the unattached end.

In designing the trestle and the falsework for the center, steel viaduct practice was followed. Towers with four legs were braced in horizontal planes at determined intervals and in the planes of the legs with X-bracing for each vertical panel. The drawing of the falsework Fig. 2 shows the arrangement except that in the case of the trestle the legs of the bottom panel were given a transverse outward batter to widen the bases of the towers, as shown by Fig. 1.

As stated the purpose of the trestle was to erect the centers and forms and to handle the reinforcement. Practically all the concrete was placed by chuting from mixing plants located on the high banks of the gorge spanned by the arch. A 40-ton derrick traveler was planned, and to bring it well above the loads it had to handle, the top of the trestle was established at a height well above the crown of the arch ribs, as shown by Fig. 1. A uniform span of 30 ft. was adopted both between tower legs and between towers. The tower legs were made of 12 x 12-in. x 32-ft. timbers spliced together with steel plates to which the timber transverse bracing and the 1¼-in. steel-rod sway bracing were attached. The tops of the legs were capped transversely with 12 x 12-in. timbers. These caps carried a 24-in. I-beam on each side of the trestle and the traveler rails were bolted to these beams. The trestle was 33 ft. 6 in. wide on top, 375 ft. long and 145 ft. high at the highest point. There were four vertical panels in all the towers in the valley bottom while the towers on the slope had three, two and one panels as their height decreased.

Standing 145 ft. high, with its slender posts and bracing, the free end of this trestle presented an appearance of lateral instability which its action in service

FIG. 3. VIEW OF CENTERING WITH RIBS COMPLETED

belied. With the traveler derrick swinging loads of several tons, 30 ft. or more to one side, the structure showed no appreciable side sway. In March, during several of the heaviest wind storms, with the traveler working 75 ft. from the end, transit observations showed a sway of only ⅛ in. This remarkable rigidity must be attributed to the precision of the framing and erection which was virtually as great as that which would be employed in a steel structure for permanent service.

As illustrated by Fig. 2 and the views Figs. 1 and 3, the falsework for the centers consisted of four viaduct-type timber towers. Oregon fir timbers 20 in. square were used for the legs. Two short 15-in., 50-lb. I-beams were anchored to the footing pedestal and carried ¾-in. bearing plates on which the posts were seated. These posts were 63 ft. long and on their tops carried pairs of 15-in., 50-lb. I-beams. Footed on the I-beams were 12-in. square timbers, three from each post, radiating out fanwise to support segment beams which were bolted through steel stirrups capping the ends of the radial timbers. The segment beams were pairs of 12-in. 35-lb. channels bent to the curve of the arch. The remaining bracing and the essential dimensions are given by the drawing Fig. 2.

It will be noted that there are only four bearings in any line of vertical supports from the footing pedestals to the segment beams, a height of over 100 ft. As these joints were very carefully framed and assembled their compression was slight. As stated the centers settled ¾ in. when loaded and when the centers were lowered the arch ribs dropped ¾ in. more. Contemplating the old type falsework, the specifications had called for an arch camber of 3½ in. The falsework was built to this requirement but less than half of the expected possible settlement occurred. A noticeable feature of the centering is that no wedges were used. To lower the centers, therefore, jacks were set on the pedestals, taking a lift under the angles used to anchor-bolt the posts, and with the jacks carrying the load the I-beam webs were cut with torches.

The erection of the centering was begun March 11, and was completed ready for the arch rib forms on April 4. As the concreting of the arch ribs and struts was finished, as already stated, on May 3, it required a little less than 2½ months to build the centers and the rib and strut forms and to place the concrete for ribs and struts. This is submitted by the engineers and the contractor as being remarkably fast progress. The bridge is being built by the city of Pittsburgh, Pa., John D. Stevenson, assistant chief engineer, in charge of bridges. Fred C. Coder was engineer in charge of construction. The contractor was The E. M. Wichert Co., Pittsburgh, Pa.

Railway Car-Icing Plant to Serve Refrigerator Trains

Standard Layout for Icing Trains While Changing Engines at Division Points—Ice Making, Storing and Handling

TYPICAL of standard plans for railway car-icing plants which have been adopted by the Pacific Fruit Express Co. is the plant at Ogden, Utah, a plan of which is shown in Fig. 1. These standard designs for track layout, buildings and equipment were prepared in connection with a program for establishing a number of new plants along the Southern Pacific Ry. and Union Pacific Ry., since the time and cost of construction will thus be reduced materially. In the Ogden plant a one-story building 100 x 150 ft. contains the compressor room and ice-making or freezing room. Adjacent to this is a two-story building 85 x 165 ft., with the first floor holding ice for the day's work and an upper room for storage. Beyond this is an ice house 150 x 165 ft., divided into two sections of 10,000 tons capacity each for general storage and winter storage.

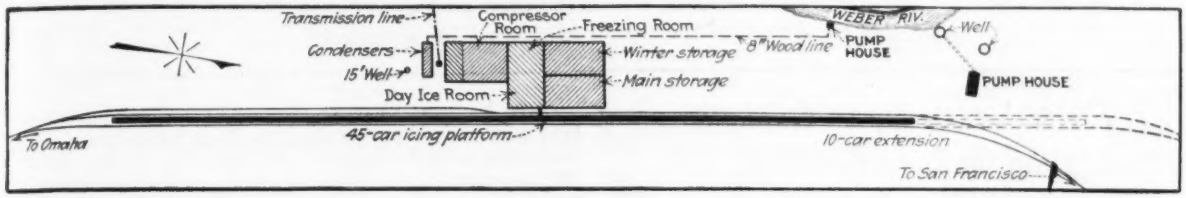


FIG. 1. CAR ICING PLANT AT OGDEN, UTAH

Ice blocks on the first floor of the day storage building are trucked to an inclined conveyor which carries them to the upper end of an inclined chute extending to the roof of the icing platform, as shown in Fig. 2. This chute connects with a similar but steeper chute at right angles to it, which in turn delivers the blocks to a conveyor running along the center of the icing platform. Men with ice tongs pull the blocks off the conveyor and slide them over hinged aprons to the hatches of the car bunkers. Two tracks long enough for solid trains of 45 cars are served by this elevated platform and provision is made for increasing this length to take 55-car trains.

Reinforced concrete is used for the buildings, which have sides of pilaster and curtain-wall construction and floors of the flat-slab type on girders between columns

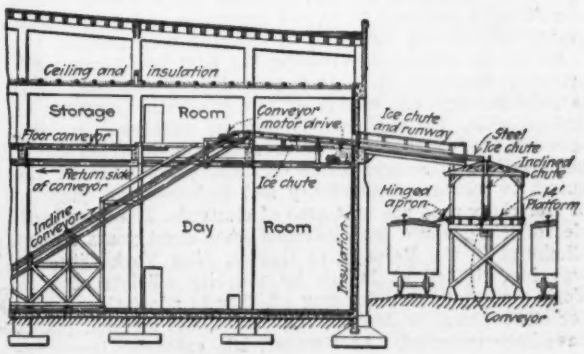


FIG. 2. ICE ROOM AND ICING PLATFORM

spaced about 21 ft. c. to c. A wooden false ceiling with insulating material above is placed over the storage room, leaving a ventilated air chamber between this ceiling and the plank roof. Corkboard insulation is used in the storage rooms.

Railway icing stations served by this company have platforms usually 2,460 ft. long to accommodate two solid trains of 55 refrigerator cars. This arrangement is found more economical than a side or single-track platform, both in the handling of ice and in the time required for icing trains. Shorter platforms cause delays and extra switching of cars. The platform is a frame structure approximately 14 ft. wide with shelter roof and with an endless chain conveyor extending along the center line.

The track layout is so arranged as to enable the railroad to bring inbound trains of refrigerator cars direct to the icing platform with the road engines. The incoming engine and caboose are then cut off and the outgoing engine and caboose are coupled on. Train inspection is accomplished while icing is under way and the entire operation is made without the necessity of moving the train until it is ready to depart. This arrangement decreases the loss of time and the cost of switching at division points, the former being of special importance in the transportation of perishable freight.

The Direct Oxidation Method of Sewage Treatment

Papers and Discussion Before the Cleveland Convention of the American Society for Municipal Improvements

Electrolytic or Direct Oxidation and the Lima Deadlock

By George W. Fuller

Of Fuller & McClintock, Consulting Engineers, New York City

THE use of electricity as a purifying agent has appealed and continues to appeal fascinatingly to the lay mind. For more than thirty years arrangements in which use is made of electricity have come up for consideration. The writer first became acquainted with the so-called "Webster process" of this type in London in 1890. In test plants this process was shown to be to a considerable extent a coagulating arrangement whereby electricity was used to decompose iron or aluminum electrodes, thus forming hydrates of these metals. The effective work was chiefly done in a manner more or less resembling the coagulating effect in water treatment plants in which use is made of sulphates of iron or alumina.

Undoubtedly there is some electrolytic decomposition of water even where iron and aluminum plates are used and bubbles of oxygen and hydrogen are released. Some of the oxygen is released in an atomic or anodic state whereby it has a high power for oxidizing even inert organic matter. Excessive cost has kept this process from general adoption.

Harris Process—The writer investigated the "Harris magneto-electric process" at Louisville at considerable length in 1897, but they did not offer reasonable prospects for practical success. Plants of this type were installed for sewage treatment at Santa Monica, Cal., Oklahoma City, and a few [six] other places [in Oklahoma—Editor.] Practical accomplishments were small and all of the plants have been abandoned except the one at Santa Monica which was found a year ago to be still in service under conditions greatly overtaxing its limits of effective performance.

Recent Developments—During the past ten years much attention has been given to improved arrangements, made largely through the efforts of the Landreth Company of Philadelphia, by the introduction of revolving paddles between the electrodes to remove the gases which cause polarization. Use was made of lime, presumably at the outset to increase conductivity and to lessen the quantity of electricity used per unit area of electrode. The "Landreth electrolytic process" was installed some eight years ago at Elmhurst in the Borough of Queens, New York City. It was investigated at length by the city officials of New York, preparatory to deciding whether to adopt the process for other plants within the city limits, but no such plants have been installed. At Decatur, Ill., extensive investigations were undertaken shortly thereafter, but the process was not adopted and after a delay of some five or six years trickling filters are now being installed there.

Clark Process—The "Clark process" of the electrolytic type was devised and patented by J. M. Clark six or eight years ago, when it received some attention in New Jersey. The successor to this process is known as the "Selo method," which is somewhat similar to the "Landreth electrolytic process" except that in the "Selo method" there is separate treatment of the sludge, to which salt is added, and there are certain differences in plant details. By this method the sewage is dosed with milk of lime in an agitating tank, then settled in a circular tank having a Dorr thickener and passed through an electrolyzer. The sludge is mixed with a solution of salt and electrolyzed, disinfected and deodorized by the sodium hypochlorite which is formed by the use of electricity. It is claimed that the sludge is rendered drainable to 60 per cent moisture in 48 hours so that it may be used as a fertilizer.

A plant of the "Selo method" was installed several years ago by the Thermoid Rubber Co. at Trenton, N. J. It is understood that the electrolytic features of this plant added little or nothing to the quality of sewage effluent and it was found on a recent visit there that the electrolyzers had been removed.

Direct Oxidation Process—The Landreth patents coverering the so-called "direct oxidation process" are controlled by the Municipal Sewage Disposal Co. of Philadelphia, which has installed two plants, one at Phillipsburg, N. J., and another at Allentown, Pa. At Phillipsburg the plant has been in service for about two years and last spring an extensive set of tests was made by the State Department of Health but the results have not yet been made public. At Allentown a 3-m.g.d. plant at a cost of about $180,000 was installed and has been in intermittent service for nearly a year. Sanitary sewers in Allentown have been built only to a limited extent and it is understood that at present there are only about 700 sewer connections, which produce a volume of flow which permits the treatment plant to be operated only a few hours each day.

At Easton, Pa., a test plant was installed in 1919 for demonstrating the practicability of the improved devices of Mr. Landreth, in which use is made of both electricity and lime, followed by sedimentation. This test plant was studied by several engineers and chemists of Philadelphia with results as stated in a paper presented to the Franklin Institute in 1919. The Easton plant was also investigated by the Pennsylvania State Department of Health with results as summarized in *Engineering News-Record* of Sept. 18, 1919, p. 569. [This summary was followed by a summary of the Franklin Institute report.—Editor.]

As the "direct oxidation process" now stands, it may be fairly stated that it has received widespread attention and that the merits of the process have come into sharp controversy. This means that adequate data for giving the

process a true rating are seemingly lacking, at least to the extent of being persuasive to the minds of many. Briefly, the opponents claim this process to be no more efficient than if lime alone is used; that the process is unreasonably expensive to operate, especially where the sewage contains a very high amount of hardness requiring a large dose of lime; that the effluent, while very well clarified due to the coagulating effect of magnesium hydrate, is not purified of its organic matter to a degree sufficient to serve the local requirements at many places; and that the destruction of bacteria by the process is not due to the action of electricity but on the contrary to the excess of caustic lime in the effluent, which ranges from 30 to 80 parts per million.

On the other hand, the proponents of the "direct oxidation process" claim that it is cheaper to install than plants of the biological type; that it permits an attractive looking and inoffensive plant to be located within built-up portions of the city; and that it allows the sludge to be handled in an inoffensive condition and dried so as to produce a product that is marketable.

Sewage Treatment Situation at Lima, Ohio—It is not the purpose of this paper to go into great technical detail but rather to outline some of the main comparative features of the so-called "direct oxidation process" and of so-called "biological processes" as they have come into competition at Lima, Ohio. Controversial aspects of the local sewage problem as it now stands at Lima have produced a deadlock for the present year, leading to a series of claims and counter claims which are of some interest and perhaps of value as a warning guide.

Lima is a city of about 45,000 population with several large manufacturing plants and a growing population outside the present city limits. It is located on the Ottawa River, having a drainage area of about 100 square miles. The flow of this stream, which passes through the heart of the city, becomes almost nominal during summer and is lessened by storage reservoirs above the city into which water is pumped from the river during periods when there is a substantial flow. The result is that the stream bed is practically an open sewer from which offensive odors emanate for a distance of several hundred yards on either side.

Due to the complaints of riprarian owners below, the State Department of Health under the terms of the Bense Act ordered the city to purify its sewage. Fuller & McClintock made a report in 1916 on relief sewers, intercepting sewers and treatment works, recommending the adoption of the activated-sludge method. But little was done during the war period and beginning in 1919 construction work related largely to relief sewers to improve conditions in the built-up part of the city where the original combined sewers proved inadequate.

In 1921, Fuller & McClintock were engaged to design intercepting sewers and treatment works. After considering the problem in detail they recommended the adoption of fine screens followed by trickling filters and final settling tanks equipped with Dorr thickeners. This decision, differing from the preliminary report of 1916, was made partly because of inability, with the activated-sludge process, to treat the sludge in a way to yield any proceeds from its sale, but chiefly because under the Ohio law it is highly desirable, if not essential, to keep the operating expenses of sewage treatment plants at a minimum.

Under the terms of the amended Bense Act the interest charges on bond issues required for the construction of sewage treatment works when ordered by the State Department of Health to correct a nuisance, are not required to be paid from the general fund raised by taxation, to which there is a maximum limit of 15 mills per dollar of assessed valuation. Operating expenses for treatment works, on the other hand, must be paid out of funds raised by taxation and must be kept within the 10-mill rate unless there is a special election to authorize, by vote of the people, a special tax above this limit; but in any event a limit of 15 mills cannot be exceeded.

Plans and specifications for the fine screens and trickling filters were completed and approved by the State Department of Health, subject to the provision that preliminary sedimentation would be required if found necessary. A letting was authorized, with bids to be received on April 1, 1922. About a week prior to this date, the Municipal Disposal Co. of Philadelphia persuaded the City Commission at Lima to postpone the date of the letting and to take steps towards receiving alternate bids for a plant of the Landreth "direct oxidation" type. Plans and specifications for the latter were prepared and submitted to the State Health Department for approval. Specific data on the cost, method and adequacy of performance of the "direct oxidation process" have been requested of the city officials by the State Department, and Col. George A. Johnson has been retained by the city to obtain information in respect thereto.

Several months have elapsed during which the merits and demerits of the trickling filter method (Contract A) and of the "direct oxidation process" (Contract A-II) have been debated pro and con by the various parties in interest. Briefly, the situation may be summed up by the following paragraphs:

1. The installation cost of pumping station and treatment works by the trickling filter method, with its established record of adequacy and successful performance for a quarter of a century, was estimated in December, 1921, at $691,000 as compared with a sum said to be about $400,000 for the proprietary arrangement with a number of novel features not yet worked out on a practical scale on a sizable plant.

2. The annual operating cost of the trickling filter method, including all pumping, fine-screen operation and sludge disposal from final settling tank, is estimated to range from $13,000 to $15,000 in comparison with which is an estimated sum of $40,000 for the "direct oxidation" process. In this latter process it will be necessary to use, according to tests at Lima, about 2,800 lb. of lime per million gallons and about 150 kw.-hr. per million gallons for electrolyzers, in addition to the costs of pumping and screen operation, attendants for pumps, fine screens, electrolyzers, Dorr tanks, and sludge drying plant (three tons dry basis per million gallons) of the vacuum filter type. These estimates in each case are for fine screens operating at the rate of 4 m.g.d. for twelve months per year and secondary treatment for the seven warmer months. As the quantity of sewage increases later the financial disadvantage of the "direct oxidation" process will increase.

3. As to quality of effluent, the trickling filter plant will produce an adequately clarified and non-putrescible effluent, suitable for discharge into the Ottawa River. As regards clarification, the "direct oxidation" process, when an adequate dose of lime is applied, will produce the same result. But as to the removal of dissolved organic matter the evidence indicates that the "direct oxidation" process is no more efficient than "excess lime treatment" alone and that dissolved organic matter is not removed with substantial completeness but is simply left undisturbed in a sterile effluent so long as sufficient caustic alkalinity remains.

4. The "excess lime treatment" for sewage is not a novelty but was employed at London more than 30 years ago and was abandoned on account of the secondary putrefying reactions which took place with the organic matter on the bottom and sides of the River Thames.

* * *

One Year's Operation of Direct Oxidation Sewage-Works at Allentown

By Harry F. Bascom
City Engineer, Allentown, Pa.

ALLENTOWN has a population of about 90,000. Plans for direct-oxidation sewage-works for a part of the city, prepared by me, were approved by the Pennsylvania Department of Health, Oct. 1, 1919. The ultimate sewage flow tributary to the works is estimated at 1.91 m.g.d. of sewage uncontaminated with trade wastes with 2.8 m.g.d. maximum. The plant includes fine screens with ¼-in. circular perforations; grit chambers; a Venturi meter; lime storage and dosing apparatus; three sets of 1-m.g.d. elec-

trolyzers, each consisting of 48 plates spaced ⅜ in. apart, the plates being cleaned by revolving paddles; sedimentation basins, with a detention period of 1½ to 2 hours at full 3-m.g.d. capacity; and sludge drying beds.

During the past year the plant treated 73,000,000 gal. of sewage without the slightest evidence of nuisance or complaint and produced an effluent which was consistently and uniformly stable and of low bacterial count.

TABLE I—RESULTS OF SEWAGE TREATMENT AT ALLENTOWN, PA.

	Raw Sewage P.P.M.	Effluent (1 Hr. Settling) P.P.M.	Per Cent Change
Suspended solids			
Total	150	69	—54
Volatile	110	46	—58
Oxygen consumed	17	8.1	—53
Free ammonia	21	13	—33
Nitrogen			
Dissolved	10.4	7.7	—26
Total	24.0	14.6	—39.1
Chlorine	117.0	123.0	+ 5
Alkalinity (as $CaCO_3$)	287.0	*50	.....
Bacteria			
Total 37°C	2,036,000	12,000	—99.6
B. Coli	87,000	18	—99.98

* Causticity as CaO

The sewage is a normal sanitary sewage and its composition as well as the average composition of the effluent is shown in Table I.

Allentown is unfortunate in that its water supply is well above the average in hardness and therefore [the sewage] requires much more lime than many other communities. Accurate records of cost show that when the plant operates at full capacity, or 3-m.g.d., the cost would be as given in Table II.

TABLE II—OPERATING COSTS, ALLENTOWN SEWAGE-WORKS

Unit cost per 1,000,000 gal., based on operation at full 3-m.g.d. capacity [deduced by Mr. Bascom from figures for amount treated "during the past year," averaging 0.2 m.g.d.—*Editor*].

Power 213 kw.-hr. @ 2.8c.	$5.96
Lime 0.6 ton @ $9.10 per ton (86% CaO)	5.46
Operators: 1 @ $135; 2 @ $125; 1 @ $100 per mo.; 2 laborers @ 40 c. per hour	7.61
Heat	.08
Light	.17
Miscellaneous supplies and repairs	1.02
	$20.30

Sludge—The sludge as removed from the sedimentation basin contains 94 per cent moisture and amounts to 21 cu.yd. per million gallons. After 4 to 6 days drying on the sludge beds in normal weather the volume shrinks to 11 cu.yd. and the moisture content drops to 71 per cent. Therefore when dry the sludge will amount to about 3 cu.yd. per million gallons.

The wet sludge from the sedimentation basin was absolutely free of colon bacilli, contained 44,000 per c.c. of total bacteria and when diluted with river water and distilled water had a stability of over 99 per cent with methylene blue in dilutions ranging from 1 to 25 up to 1 to 1,000.

During the year the sludge has in the main been satisfactorily used for filling around the plant, although in some instances truckers have carted it away and used it on their farms, and they report that it is a very good growth stimulant, soil corrector, and improves the mechanical property of the soil.

Several improvements have been made in the lime dosage during the year, a new slaking chamber installed and the lime added further upstream from the electrolyzers, giving better slaking and mixing, also effecting a saving of approximately 25 per cent in the quantity of lime used.

Lately a new type electrolyzer was installed and tested out, showing a reduction of 50 per cent in the hydraulic head required as well as an electrical efficiency considerably greater than the older type. This unit has the same effective electrode area as the older ones but contains only a single row of ten banks of electrodes and the agitators reciprocate instead of rotate, being driven from the top instead of the side.

Comment has been frequently made that the direct oxidation process is no more efficient than lime alone. In this connection a great number of tests have been made at Allentown both by the city chemist and by other investigators and the results are conclusively in favor of the direct oxidation process, which gives an effluent that shows a greater reduction in oxygen demand, oxygen consumed, organic nitrogen and bacteria.

These tests also showed that the effluent produced by lime treatment, even though practically sterile when discharged, will putrify if mixed with river water, while that from the direct oxidation process will stand up indefinitely.

Conclusion—A very significant feature about the operation of the direct oxidation process is that it is mechanical in nature and depends for its success, not upon the delicate adjustment of conditions in an endeavor so far as possible to favor the caprices of bacterial life, but solely upon simple mechanical contrivances whereby lime is fed into the sewage in sufficient quantities to render that sewage always slightly but definitely caustic, and thereafter to maintain an uninterrupted charge of electric current in the electrolyzers. Outside of these features the process is automatic.

Except in the screen room, where the raw sewage passes over the screens, there is no odor of sewage, stability being obtained in the electrolyzing units without production of odor. No odors are present outside the building even from the sludge beds. Fly and mosquito nuisances such as is always prevalent at all other kinds of sewage-works are unknown at the Allentown plant.

The plant operates irrespective of weather or temperature conditions. The variation in flow of sewage through the electrolyzers up to the capacity of the unit has no effect upon the current required; in other words, any quantity of sewage up to the capacity of the unit requires the same amount of current as the rated flow.

* * *

Discussion of Fuller and Bascom Papers

Col. George A. Johnson, consulting engineer, New York City—In no other branch of public sanitation has there been less real progress made than in sewage treatment.

Bacterial purification of sewage is only incidental to any "purification" which it undergoes in the great bulk of the accepted sewage treatment processes of today. Keep the stream "sweet," attractive to the eye and inoffensive to the olfactory sense, and leave to the water purification plan the job of making the water supply safe for human consumption. That is the concept of the sanitary mind today.

I question the soundness of such promises when I realize that the cost of ideal sewage treatment is one of the real reasons why we do not strive for higher degrees of sewage purification. Some years ago Hazen said that the public derived more benefit from one dollar spent for water purification than from ten dollars spent for sewage treatment. In a broad sense he was right. Money spent for water purification returns a *direct* measure of protection of the public health against water-borne disease. Money spent for sewage purification results in an incomplete and indefinite benefit. It *minimizes* the danger from pathogenic germs by reducing their number. It cannot give absolute protection as can water purification, because even if every city, town and village in the country should treat its sewage to a point of innocuousness before discharging it into public waterways, it must still be remembered that those waterways drain areas populated or traveled by human beings whose excreta are not always collected in sewer systems, but sometimes are deposited at points on the watershed from which they find their direct or indirect way into the nearest stream or lake, thus to pollute it, maybe dangerously, and in any event incontrovertibly to render all surface water potentially unsafe for human consumption unless properly purified before being delivered through the mains to the consuming public.

Everything Incidental—Today, after thirty-five years' practice beginning at the Lawrence Experiment Station of the State Board of Health of Massachusetts, we have "advanced" to a point where we judge the *efficiency* and worthiness of a process of sewage treatment by its ability to turn out a fairly clear effluent which by itself will remain

stable for a few days. Everything is incidental. High bacterial purification is considered desirable but no particular point is made of it.

Why are we willing to allow sewage treatment plants to pour uncountable billions of bacteria into our public waters every hour of the day, when such waters must be used later for public supply? Why are we willing to accept sewage treatment works which we know with positiveness will fail several times during an average year, particularly during cold weather? Why do we complacently impose upon the water purification plant the full responsibility of protecting the public health against water-borne disease?

If it were the rule for every community to purify its sewage thoroughly, and not incompletely and uncertainly, as is almost always the case, all would be well; but where only the elimination of gross nuisance in streams is the prime consideration, as we know it mostly is, it is not easy to convince the people of one municipality that they owe a debt of common decency to their neighbors which they should pay—even if their neighbors are not similarly minded—and so become pioneers in a movement which would do so much toward actually cleaning up our public waterways and lessening the growing burden on water purification systems.

Direct Oxidation—Everyone knows, or should know, that of all the processes of sewage treatment in practical operation today there is only one which for its success does not depend upon the capricious activities of bacterial life. The "direct oxidation" process is not a biological system but a combination of mechanical devices depending not at all upon bacterial actions—which fail signally at times and at best are unreliable—but merely upon the faithful operation of certain relatively simple mechanisms. An effluent results which is practically free from suspended matter, which is stable and which contains but very few bacteria. Furthermore, the effluent is uniformly stable, as is the sludge—which is true of the sludge from no other process. Moreover, there is no local nuisance created around such plants, something which has never before been true of any other type of sewage-works. All of these facts were well demonstrated during my recent test of the direct oxidation plant at Allentown, Pa.

The cost of sewage treatment by the direct oxidation process is fairly comparable with that of other well-known methods which are far less easily managed, less reliable and all of which are certain nuisance breeders in some particular and in varying degree. At Trenton, N. J., for example, where I am preparing plans for a plant of this type, the total cost of treatment, including all charges, is estimated at about $20 per million gallons.

It is true that this process is patented, as is some of the apparatus used in it; that it is exploited commercially. I cannot see, however, wherein these facts need be given adverse consideration. We can use other processes, even the patented Imhoff tank, and obtain inferior and always uncertain results at less cost; or we can use this process, which, in the minds of some oblique-minded people, bears the stigma of a commercial exploitation, and obtain what we want and need, continuously and reliably, winter and summer, and at reasonable cost.

Must we shut our eyes to the advantages of definitely cleaning up our public waterways, continuously and permanently, and not as an intermittent and incomplete proposition, merely because a process which gives great promise of being able to serve this purpose best is a patented one susceptible of commercial exploitation? Some municipalities and some engineers adopt a discriminatory attitude toward patented devices, in some cases with good and sufficient reason, no doubt, but in the case in point if we favor the direct oxidation process over all others solely because of its merits and potentialities, and where cost factors are not clearly prohibitive, are our efforts to be discredited on the questionable grounds of unreasonable bias and unwarranted idealism?

T. Chalkley Hatton, chief engineer, Milwaukee Sewage Commission—Mr. Fuller has well stated that "the use of electricity as a purifying agent has appealed and continues to appeal fascinatingly to the lay mind." He might have gone a step further and stated that to many lay minds electricity can accomplish almost any service if properly applied; that because of its *mysterious workings* its field is practically unlimited and therefore it has again and again in the past thirty years been used to remove the impurities from sewage-laden water, and I fancy there is not an engineer familiar with sewage treatment work who has not had more or less to do towards either trying out some process of sewage or water treatment in which electricity plays a part or given such a process very considerable study. In spite of this history there has not yet been built a sewage or a water treatment plant of any considerable magnitude in which electricity plays an important part.

Several small plants have been built where electricity was used as the sole purifying agent. All of these but one have been abandoned. Two small plants have been built where both electricity and lime have been used—the Phillipsburg and Allentown plants. I believe each of these plants has three 1-m.g.d. electrolyzers but that up to date neither of them has been operated at a rate of 1 m.g.d. for the whole works. The sewage so far treated is extremely weak, ranging from 60 to 80 p.p.m. of suspended matter, with low oxygen requirements. There is no published record of either plant which would warrant the engineer in concluding that they could continuously and satisfactorily treat a typical city sewage at rated capacities or what the cost of treatment would be.

Col. Johnson's Allentown Report—I have read within the past few days a detailed report of tests of the Allentown plant made under the direction of Col. George A. Johnson. These tests covered a period of 31 days (July 18 to Aug. 18, 1922) during which the average flow was 409,400 gal. and the maximum flow 700,000 gal. for 24 hours, or from 40 to 70 per cent of the rated capacity of one unit [out of three]. The sewage was treated at these rates for three different periods of the day, the flow in the sewers being too low to provide for a continuous daily operation of the plant, and the sewage was considerably below the average city sewage in carbonaceous and suspended matters, and was therefore not typical of average American sewage.

There were 57 tests made, divided into five groups, which appears to me to be far too few to warrant Colonel Johnson or any other careful engineer of his type to make the statements contained in his discussion.

Col. Johnson estimates that the plant he is designing for Trenton will treat that city's sewage for about $20 p.m.g. including all charges; my recollection is that in his report to Lima, Ohio, as referred to in Mr. Fuller's paper, the cost was about $45 p.m.g., which included the cost of sludge drying. If he proposes to dry his sludge by means of filters and dryers, as suggested in his report to Lima, and using the vacuum filters, as mentioned in Mr. Fuller's paper, the drying alone, based upon our experience in Milwaukee, will cost him from $20 to $30 p.m.g. of sewage, with very little, if any, return from the sale of a sludge devoid of nitrogen, phosphorus or potash.

The sludge problem is very lightly passed over by those who recommend the direct oxidation process and yet all those engineers who have built sewage disposal plants of any considerable magnitude, both in this country and abroad, realize more and more, as these plants are operated, that the proper disposal of sludge resulting from any type of sewage treatment is the largest part of the problem, and one which must be faced sooner or later; and when such enormous quantities of sludge are to be disposed of as the direct oxidation process produces, the problem of its disposal becomes naturally a costly and troublesome one to solve, even though the sludge may be inodorous.

It has not been proved (to the writer's satisfaction, at least) what the cost of electric current would be to operate a million-gallon unit to full capacity month in and month out. Our experience in Milwaukee with the Lautzenheiser electrolytic process was that with new plates when treating typical sewage at full rated capacity we secured admirable results for a few weeks; that we started off with five volts on the plates and increased to 100 volts within a period of

four weeks; that the amperes started at 70 and were reduced to less than 40, and that the weight of the electrodes diminished consistently in proportion to the sewage treated.

There can be no doubt that the electrodes rapidly diminish in weight and must be replaced; that a machine with so many moving parts as the Landreth electrolyzer contains requires expensive upkeep, and that the known complexity of the varying conditions of the average sewage naturally imposes a correspondingly varied service upon the machines, influencing very largely the cost of operating this direct oxidation process.

It is not the writer's desire to cast any reflection upon the value of either the Phillipsburg or Allentown sewage disposal plants, but until they have fully demonstrated their worth by a long-time test to their full capacity, when treating typical American city sewage, and until reliable records have been secured and published, it would seem logical to go slow towards the general adoption of this process by engineers who are responsible for the expenditure of public funds in such large amounts as sewage treatment requires.

F. N. Moerk, chemist of the Municipal Disposal Co., promoter of the Landreth direct-oxidation process and contractor for the Allentown and Phillipsburg plants.

In his discussion Mr. Hatton states that the sewage of Allentown is relatively weak. Analyses show that it is almost identical with the sewage of Worcester, Mass. Mr. Hatton says he can't understand why at Lima the estimated cost for the direct-oxidation process is around $58 p.m.g., while at Trenton the estimated cost is about $20. The explanation is that at Lima the lime demand will be about 2,600 lb. of 90 per cent lime, so far as we can tell by analysis, while at Trenton it will be only 550 lb. As to the sludge problem: Future direct-oxidation plants will be equipped with Dorr thickeners. At Trenton the sludge will be used for fill. The U. S. Department of Agriculture estimates the value of the direct-oxidation sludge not on the nitrogen but primarily on the calcium carbonate content. On this basis the sludge is worth at least $5 a ton.

H. P. Eddy, consulting engineer, Boston, Mass.—After about as many years of experience in sewage treatment as were mentioned by Col. Johnson, I have concluded that while high ideals as to the degree of sewage treatment are desirable there is a cost limit which cannot be passed. Where sewage-works have fallen down is not in design and construction but in operation. This operating cost limit will apply to the direct-oxidation process, as it certainly will to the activated-sludge process. It is practically impossible now to get money for sewage-works operation, although it may be obtained for first cost. At Lima, the estimates show a big difference between the operating costs of direct oxidation and of screens and sprinkling filters. If a direct-oxidation plant were built there, and funds for full operation subsequently denied, the result might be a lime-treatment plant only.

I want to say just a word about Col. Johnson's remark on patented processes. I have never felt that we should refrain from taking advantage of patented processes. We are doing it all the time in engineering matters. Why not in sewage treatment?

Mr. Fuller—As to the remark by Mr. Moerk, chemist of the Municipal Sewage Disposal Co., there will be a variety of things to look out for in the application of the electrolytic process to the sewage of Lima where the sewers are on the combined plan and deal at times with storm water, besides having to cope with varying degrees of hardness in the water supply that makes up sewage. Mr. Moerk will have to look after the lime application in respect to free carbonic acid and to half-bound carbonic acid, both of which vary in different seasons of the year. Due to the slowness of reaction even in the presence of much mixing and agitation, a matter with which all water-works men are familiar, he will have to apply two equivalents of lime to one of magnesia. The magnesia content will vary not only due to its varying content in the public water supply but also due to infiltration water and storm water in the sewage. The direct-oxidation process, Mr. Moerk says, calls for a certain amount of causticity. In plain English, this means lime water in excess of what combines with the sewage as it goes through the electrolytic cells. The excess quantity is stated to be 30 to 50 p.p.m., and may be 80 parts. In order to get a dose of lime to give this desired amount of causticity, it will be necessary to top the aggregate combining power of three variables—free carbonic acid, half-bound carbonic acid, and magnesium. This would have to be done with the fluctuating flow of a combined system of sewers. This comment also applies to Colonel Johnson's assertion that the direct-oxidation process is a mechanical one.

In his Lima report, Colonel Johnson is strong on every-day-in-the-year operation. I believe that for a part of the time screening only will be enough. The adequacy of the data on which Col. Johnson's cost estimates for Lima are based, is in doubt in view of both the small size of the direct-oxidation plants thus far in use and the fact that they are not yet running at full capacity. As to claims that the operation of the direct-oxidation process is simple, being entirely mechanical, there are a number of chemical points that must be carefully watched. Finally, as far back as 1876, the British government called for a high degree of sewage treatment, but the demands were not met and long afterwards the Royal Commission on Sewage Disposal, although insisting on the formulation of sewage-works programs, provided also for what they called relaxation, with subsequent building up to the standard. A wedge should not be used blunt edge first.

Canada Taking Inventory of Prairie Lands

For the guidance of future settlers, what are known as "classification surveys" are being made over large and partially settled areas, in the Canadian prairie provinces under the auspices of the Topographical Surveys Branch of the Department of the Interior. From the results already obtained the new departure has been fully justified. Specimens of soils are being collected over the area investigated and analyses made at a soil laboratory established for this purpose at the University of Saskatchewan, Sask. Thus, the prospective homesteader may not only be informed as to the quality of the best soil, but also the crops which will yield the best returns. The lands inspected under the new system are classified under one of the following heads: Not open for homestead entry, suitable for immediate settlement, considered fair for settlement, lands which can be economically improved, those requiring extensive improvements, hay meadows, grazing lands, and lands of no agricultural value. Classes 2, 4 and 5 contain an acreage of good soil, which, after clearing and improvement, will be equal in value to the average improved farm of the district. Class 2 contains from 20 to 30 acres of land open or ready for breaking with little preparation. Class 4 is covered with a light or medium growth of poplar and other timber of no commercial value, while class 5 is heavily wooded with poplar and scattered spruce, birch, etc. Class 3 when improved will not be equal to the average improved farm of the successful homesteaders of the district owing to deficient acreage of cultivatible land or to some deficiency in the soil. Maps published recently by the Topographical Surveys Branch showing the classification of lands by quarter-sections for settlement purposes cover the districts around Lac la Biche and north of Prince Albert. Other maps covering other districts are in the course of preparation.

Water Power Timely Topic at Am. Soc. C. E. Fall Meeting

San Francisco Meeting Shows Lively Interest in Power Problems Because of Extensive Developments in Prospect—More Than 600 Registered—125 Inspect Hetch Hetchy Project

Engineering News-Record Staff Correspondence

THE meeting of the American Society of Civil Engineers held in San Francisco on the first week in October and devoted to "The Water Power Problem" afforded a timely opportunity for the discussion of a subject in which there is intense interest throughout the West. The degree of interest was apparent not alone from the heavy registration, but in the consistently large attendance and very close attention throughout all the sessions. The attendance at each of the forenoon sessions was about 350. Several references were made to the success of the plan of holding spring and fall meetings in various districts and the interest and enthusiasm in the local section which such meetings produced. The total registration was about 600 of which 150 were upper classmen in civil engineering courses at the University of California and Stanford. Suggestion was made that the student attendance offered a new and useful feature of such meetings that might well be encouraged in future.

Program of the Meeting—The arrangement of each of the two days' program into morning and evening sessions, with an afternoon excursion each day, afforded an opportunity for everyone to get outdoors and to either make the scheduled trip or go somewhere on his own account each afternoon without interfering with attendance at meetings. This plan was notably successful in keeping the percentage of attendance high.

Prior to the arrival of delegates very thorough preparations had been made by the local section. A variety of maps, reprints of technical articles and pamphlets on points of interest were collected for distribution and thus there was available at registration headquarters a wealth of ready information. This was very much in demand. The publicity of the convention was handled by an expert who had reporters of four daily papers present at the technical meetings and thus secured an unusual amount of publicity for the society and for the civil engineer generally.

President John R. Freeman opened the meeting on Wednesday morning with a comparison of modern hydro-electric practice, as he saw it exemplified a few days before at the Pit River plant in northern California, with early developments. One of the 40,000-hp. Pit River units develops more power than the combined output of the 150 installations operating in the vicinity of Lowell and Lawrence, Mass., only fifty years ago when he began his water power work. He was particularly impressed with the fact that only three men per shift were required on the Pit River plant, indicating the comparative economy of human effort that modern development has made possible. Mr. Freeman outlined in a broad way the possibilities of the work of the convention and particularly stressed the importance of Western power development.

Colorado River Development—A. P. Davis, in an illustrated talk on the Colorado River, stated that because it is technically and actually navigable for over 400 miles, involves international rights and can be made to irrigate 6,000,000 acres and develop 6,000,000 hp., the question of developing the Colorado has become a peculiarly national problem. An objection to developing storage on the lower basin, he pointed out, is the 90,000 acre-ft. of silt annually delivered to the lower Colorado. On the other hand, storage above the canyon could not regulate more than half of the drainage area. The Gila River alone, with only 21 per cent of the basin and contributing only 6 per cent of the water, occasionally discharges floods which for short periods peak above those of the Colorado at Laguna Dam.

A dam can be built in the Granite Gorge of Boulder Canyon, he said, that will form a reservoir sufficient to regulate the entire flow of the river above the Gila and regulate this to any desired regimen of discharge. Such a reservoir would not only completely eliminate the flood menace of the river, but would furnish the regulation and the head necessary to develop 600,000 primary horsepower and fulfill the requirements of irrigation in Arizona and California. This site is within transmission distance of large available power markets in Arizona, California, Nevada and Utah.

Feasible reservoir sites have also been surveyed at Flaming Gorge on Green River, Juniper on the Yampa, and at Dewey and Gorge Canyon on Grand River. Numerous smaller reservoirs on the smaller tributaries of the Colorado are available for local use in irrigation with perhaps some power development.

In discussion of Mr. Davis' paper, J. B. Lippincott (Los Angeles) stated that the entire summer flow of the Colorado is now being diverted and that the time has already come when the storage of flood waters must be begun. He expressed a hope that the U. S. Reclamation Service would be able, with federal aid, to undertake the development of storage and power on the Colorado, but that if that could not be done soon that federal authorities would at least allow private companies who stood ready to proceed to undertake such development. This he felt is urgent on account of the flood danger to the 50,000 people and the 500,000 acres of irrigated land along the lower reaches of the river.

Federal Water Power Rights—O. C. Merrill, executive secretary of the Federal Water Power Commission, stated that in the two years since the water power act was passed 348 applications for permits aggregating more than 20,000,000 hp. have been filed with the commission. This is more than twice the existing water power installation of the United States and more than six times all applications for power sites under federal control in the preceding twenty years.

Because of limited funds and personnel, the commission has been greatly delayed and hampered in its duties, Mr. Merrill said, but nevertheless final action has been taken on 197 applications, or more than half of the total number received. Up to Oct. 1, 1922, the commission has authorized 64 preliminary permits and 64 licenses of which 25 were for transmission lines. The 60 permits now outstanding involve about 2,540,000 hp. and the 39 licenses for power projects, 2,040,000 hp. Of the 39 licenses, 15 involving an estimated installa-

tion when completed of 1,880,000 hp. and investments of $220,000,000 are either completed or under construction. This is one and a half times as much as was constructed under federal authorization in the twenty years preceding the passage of the recent water power act. There is now more water power under construction than at any previous time in the history of the country.

F. H. Fowler (San Francisco) showed that practically all the Western coast is within a 500-mile radius of the two great sources of power on the Colorado and the Columbia Rivers. The enormous power possibilities here, however, cannot be developed economically, except in large blocks and consequently markets for the power must be found before development will be feasible. West of the Rockies coal and gas can compete with hydro-electric power only in very small areas or under special conditions, he said, and in the long run oil cannot be a competitor of hydro-electric power.

John D. Galloway (San Francisco) discussed the necessity for avoiding conflict of irrigation and power interests in water storage. Irrigation needs are best served by water stored until the dry season in low-level reservoirs that can draw from the entire watershed. Power uses are best served by continuous flow from reservoirs in the upper part of the basin where a maximum of head may be developed. Power demand in California has been increasing three to four times as fast as the population. The use of water power has increased there 138 per cent in nine years, or at the rate of approximately 9.9 per cent compounded annually. Adding steam power, the rate becomes 11.1 per cent compounded annually. By 1930 he estimated that the annual energy output will exceed 10,000,000,000 kw.-hr.

M. M. O'Shaughnessy (San Francisco) expressed a view favorable to state ownership of power development only when the entire power resources of an extensive area can be tied together and controlled as one system. Such development must be on a sound basis, he said, very unlike the impracticable scheme of the California Water and Power Act now proposed. He rated the domestic supply as the first or highest order of water use, irrigation second, and power development third. He estimated that 8,000,000 to 9,000,000 hp. would be developed in California within the next ten years.

F. W. Peek, consulting engineer, General Electric Co., Pittsfield, Mass., showed that the ultimate voltage of transmission lines would not be limited by any engineering difficulties, but rather by sources and markets for power. The cost of very high voltage lines is such that they can be built only when great amounts of power are to be transmitted. A 1,000,000-volt transmission line, for example, should have tubular conductors 6 in. in diameter hung 30 ft. apart on 20-ft. insulators, probably on towers about 200 ft. high.

H. W. Dennis (Los Angeles) said that in the territory served by the Southern California Edison Co. the population has increased over 300 per cent between 1910 and 1920. The company has increased its service from 379,900,000 kw.-hr. in 1910 to 1,079,000,000 kw.-hr. in 1921. Some 550,000 acres of land is irrigated by water pumped with power supplied by this company. An acre of arid land uses 300 kw.-hr. yearly, has its sale value increased thereby from $30 to $225 and yields an annual return of from $50 to $100 in crops. The increase of electric power production in territory served by this company has been compounded annually at the rate of 10 per cent. Anticipating steady increases in power demand for many years to come, a very extensive program of development has been laid out. During the next six years 322,000 hp. will be developed and distribution system provided at a total cost of about $125,000,000. During 1922 the company is expending $27,000,000 for new plants and facilities.

Only the conclusions were read from the paper by C. F. Loweth (Chicago) on "Hydro-Electric Power as Related to the Electrification of Railroads." His conclusions were that it is reasonably safe to assume that hydro-electric power will be a large factor in steam railway electrification under the following conditions: "(A) When it is available over such an extended area as will include a large main track mileage for the individual railroad under consideration, (B) when the several sources are tied in together so as to insure reliability, (C) when it can be contracted for extending over long periods, (D) when its cost reduced to terms of locomotive tractive effort is cheaper than that of steam generated power.

Excursions—During the forenoon technical sessions the ladies were entertained by a ladies reception committee on personally conducted trips to Chinatown, the University campus at Berkeley, and other nearby points. Ladies were also included in all three of the main excursions. On Tuesday afternoon thirty automobiles, supplied by members of the San Francisco Section and placarded with the blue shield of the society, took the visitors for a 94-mile drive. At the start of this trip some of San Francisco's tunnels, boulevards and buildings were inspected and then the caravan, aided and escorted by two traffic officers, went down the peninsula, along the Spring Valley Lakes, to Crystal Springs Dam, thence to Pulgas Tunnel, now under construction, and finally to Stanford University where refreshments and a special program had been prepared. On Thursday afternoon the trip was across Golden Gate and through the redwoods to the top of Mount Tamalpais, El. 2,600 ft.

The inspection trip over the Hetch Hetchy project, was made via Pullman train leaving San Francisco after the meeting Thursday night and returning Sunday morning. This afforded an opportunity to study in detail a typical Western development of large proportions. In the present state of the Hetch Hetchy project work is under way on a concrete and an earthen dam, an 18-mile tunnel, forebay, penstock, power house and a variety of other construction work incidental to a combined water and power development served by its own 68-mile railroad.

Award of Prizes for Papers—At the meeting of the Board of Direction just prior to the fall meeting, which was reported in the issue of Oct. 12, the committee on prizes recommended awards as follows: The Norman medal to Charles H. Paul for paper "Core Studies in the Hydraulic Fill Dams of the Miami Conservancy District," J. J. R. Croes' medal to William Cain for paper "The Circular Arch Under Normal Loads," Thomas F. Dowland prize to Gustav Lindenthal for paper entiled "The Continuous Truss Bridge Over the Ohio River at Sciotoville, Ohio, of the Chesapeake & Ohio Northern Ry.," James Laurie prize to Arthur T. Safford and Edwin Pierce Hamilton for the paper entitled "The American Mixed Flow Turbine and Its Setting." No award was made of the Arthur M. Wellington prize, or the Collingwood prize for juniors.

ENGINEERING LITERATURE

A REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

Text and Reference Book on Hydraulics

REVIEWED BY JOHN H. GREGORY

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HYDRAULICS—By Horace W. King, Professor of Hydraulic Engineering, University of Michigan, and Chester O. Wisler, Associate Professor of Hydraulic Engineering, University of Michigan. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6 x 9; pp. 237; illustrated. $2.75 (13½s. net).

In their preface the authors state that this "book is designed as a text for beginning courses in hydraulics and as a reference book for engineers who may be interested in the fundamental principles of the subject"; and they also go on to say that "tables of coefficients are given which are sufficiently complete for class-room work, but the engineer in practice will need to supplement them with the results of his own experience and with data obtained from other published sources. The book must therefore be considered primarily from the standpoint of the instructor, and only to a limited extent from that of the practising engineer.

The text is divided into eleven chapters. Following a brief introductory chapter are two on the principles of hydrostatic pressure and on pressure on surfaces; and after these come two chapters on immersed and floating bodies and on the relative equilibrium of liquids. The next chapter is devoted to the principles of hydrokinetics. The four following chapters, perhaps the most important in the book, treat of the flow of water through orifices and tubes, over weirs, through pipes, and in open channels. The last chapter takes up briefly the subject of hydrodynamics.

Taken as a whole the text is well written, and it is evident that the authors have a good understanding of the subject. In places, however, the text could to advantage be simplified, so that the student would more readily grasp the subject, which, to many is "dry."

As a beginner's textbook, and in the hands of a competent instructor, preferably one who has had enough practical experience to know the limitations of the subject, the volume should prove satisfactory for class-room work. At the end of each chapter, except the first, numerous problems are given—in all a total of 168—a feature much to be commended.

As a reference book, the practising engineer will find only a limited treatment of the subject, as was to be expected from the statements made in the preface by the authors. On the other hand, the engineer will find certain phases of the subject given a somewhat different treatment from that ordinarily found in other textbooks on hydraulics, and well worth reading.

The tables are not numbered, which is to be regretted; and the formulas are not numbered consecutively through the book from beginning to end, new numbering beginning with each chapter, which is also to be regretted. In the practical solution of everyday hydraulic problems, diagrams are very commonly used. No such diagrams are given in the book; an omission, which, in the writer's opinion, should be corrected in subsequent editions. The student should have brought to his attention in a course in hydraulics the use of diagrams as a supplement to numerical computations.

In places, the authors use a nomenclature somewhat different from that used in other books on hydraulics. This comment is not to be construed as a criticism, but rather to call attention to the fact that a standard nomenclature in hydraulics is greatly to be desired.

The illustrations are well executed and in general the book is well made. An index is included, but there is no separate index of tables.

Turbines and Water-Power Installations

REVIEWED BY LEWIS F. MOODY

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BERECHNUNG UND ENTWERFEN VON TURBINEN—UND WASSERKRAFT—ANLAGEN, Mit einer Anleitung Zur Anmendung des Turbinenrechenschiebers—Von Ing. Holl. In dritter auflage neu bearbeitet und erweitert von Dipl.-Ing. E. Glunk. München und Berlin: R. Oldenberg. Paper; 7 x 10 in.; pp. 181; 41 illustrations. 225 marks in paper; 270 bound.

There have recently been signs that the publication of technical works in Germany which had been interrupted for a long period by the war is now being actively renewed. Several new editions of publications issued before the war have appeared. In any field in which rapid progress is being made, it is questionable whether it is worth while to attempt to bring up to date technical works which have been published a considerable number of years before, and the result of such efforts is frequently disappointing. The work here considered is a case in point.

The original book by Holl was published in 1908 and, as stated in the preface, it was prepared as an explanation of a special slide rule which Holl had devised as an aid in hydraulic turbine computations. From examination of the plans of the slide rule as illustrated in the book, the slide rule itself seems to have gone out of date in a number of particulars.

The period from 1908 to the present has witnessed a revolution in the development of hydraulic turbines and the development of the modern turbine has taken place almost entirely within this period. This development is still continuing at what seems to be an accelerated rate. It is therefore not surprising that the bulk of the material of the book has gone out of date since its original publication.

This period also witnessed the death of the author and the second edition (1913) bore a note by Professor Reichel, explaining that owing to the author's death no attempt had been made to revise the book. Professor Reichel expressed his opinion in the note that the book represented such an intimate knowledge on the part of the author in the field of water-power engineering and that the material was so wisely selected for the small space it occupied that even aside from the use of the slide rule the book was of value.

In the present edition a strong effort has been made to bring it up to date, but although a considerable amount of new material has been added by E. Glunk, and although considerable revision is evident, neverthe-

less it is not believed that the book in its present form will prove to be of much value, particularly to American engineers.

The modern turbine is largely an American turbine and the pre-eminence which used to be claimed for German engineering in this field certainly does not exist today. A book which practically ignores the great modern developments which have been carried out in the United States and Canada, as this one does, must naturally be virtually handicapped. A note has been added on the Station No. 3 Extension of the Niagara Falls Power Co., but it is very inadequate. Much of the material presented in the plates and text will be recognized at a glance as being out of date. For example, the highest efficiency shown for impulse turbines is 83 per cent and the highest efficiency for Francis turbines is 84 per cent.

A considerable amount of space on the Holl slide rule is taken up with turbines having from two to eight runners on a shaft, representing types of installations of but little interest today. No design is shown of a strictly modern turbine and no reference is made to such important features of moderr power development, for example, as the differential surge tank, the Johnson valve, or the new forms of draft tubes.

It is almost too much to expect that a book should present the latest results from high specific speed runners and in many other features of the turbine of today, since new results are continually being obtained and new features introduced with surprising frequency. The engineer who has undertaken the revision of the book is, therefore, not entirely to blame for the inadequacy of the work for present use.

The latter part of the volume contains some material of value in its descriptions of a number of European power developments. There are also a useful collection of formulas and construction data in an appendix.

Marvels of Science and Nature

THE OUTLINE OF SCIENCE: A Plain Story Simply Told—Edited by J. Arthur Thompson, Regius Professor of Natural History in the University of Aberdeen. With 40 Colored Plates and 800 Illustrations in Black and White (in the entire four volumes). Vol. II and III. New York and London: G. P. Putnam's Sons. Cloth; 7x11 in.; pp. 299-564 and 565-864. $4.50 a volume.

The middle two volumes of this work follow the same general lines as were indicated in the brief commendatory notice of the first volume that appeared in these columns on July 20, p. 115. It is now possible to get a better general idea than before of the work as a whole, although there is still another volume to come.

Microscopy, The Body-Machine, Darwinism Today, Natural Science—including Birds, Mammals, and the Insect World—and the Science of the Mind are dealt with in the second volume. The third volume opens with a short section on Psychic Science, by Sir Oliver Lodge. After the break in Natural Science caused by the injection of the two sections just mentioned, Botany is presented. Then come Inter-Relations of Living Creatures, Biology (by Julius S. Huxley) and Characteristics of Living Creatures. Chemistry has two sections—on its romance and its uses—: Meteorology, one, Applied Science, three—Marvels of Electricity, Wireless Telegraphy and Telephony, and Flying.

Certainly "the intelligent student-citizen, otherwise called the 'man in the street,'" for whom the publishers' jacket says the work is intended, would profit by a more logical arrangement than has been followed—as might also be expected in an "Outline of Science." If the illogical sequence is due to the exigencies of gathering material from various sources and publishing it while fresher than would be possible under a logical grouping, let it be hoped that subsequent editions will be improved in arrangement.

Except for the names of Sir Oliver Lodge and Julian S. Huxley, the reader is left in the dark as to the authorship of the various sections thus far published. He may assume either that all the other sections were written by the editor or else that they were so largely reworked by him as to make them virtually his own.

Thus far engineering has been let alone, except as it comes in, although not by name, in the three sections on Applied Science that close the third volume. Under Marvels of Electricity there are some statements about hydro-electric power, electric heating and the electrification of railways that may mislead the uninformed. It is not even hinted that the choice between coal and falling water as a source of power is largely a matter of comparative capital and operating costs. A statement that electric current may be much more efficiently converted into electric heating than electric lighting, followed by remarks about the various uses to which electrically derived heat is put, may lead some to wonder why so few buildings are heated by electricity.

The over emphatic and the spectacular which every writer and editor of essays and books on popular science should guard against are illustrated on p. 794, where we read that electric energy "will drive the transcontinental express up the dizzy heights of the Rocky Mountains." Again, one of the illustrations bears this subtitle: "A scene on the Chicago, Milwaukee and St. Paul Railway, the largest electrical railway system in the world, *running practically across America.*" The British author of the four words we have italicized would be convinced that "practically" is hardly the word to use before he had walked the 1,000 miles from Chicago to New York City. A few pages on, the reader is told that the "longest stretches of main line yet electrified" are one 440 and another 211 miles in length, but he is not told that the C. M. & St. P. "system," mentioned under the illustration, comprises 10,000 miles of track.

Such details as the foregoing are unimportant compared with the general soundness and excellence of the three volumes already published. Those who have had the pleasure and profit of seeing these volumes will await the final volume with interest.

Handy Six-Place Tables

SIX-PLACE TABLES: A Selection of Tables of Squares, Cubes, Square Roots, Cube Roots, Fifth Roots and Powers, Circumferences and Areas of Circles, Logarithms of Numbers, Logarithms of the Trigonometric Functions, and the Natural Trigonometric Functions. New York and London: McGraw-Hill Book Co. Flexible; 4 x 7 in.; pp. 124. $1.25.

The justification for this book lies in the prefatory statement that it is "a pocket-sized book of tables such as are in regular and continuous use by engineering students and instructors, and, to a certain extent, graduate engineers in their professional work." Six-place tables have a definite place not filled by those of four or five places and the saving in bulk over the occasionally more useful seven-place has a definite advantage.

Colloids in Theory and Practice

REVIEWED BY MALCOLM PIRNIE

Of Hazen & Whipple, Civil Engineers, New York City

THE CHEMISTRY OF COLLOIDS AND SOME TECHNICAL APPLICATIONS—Second Edition. By W. W. Taylor, M.D., D.Sc., Lecturer in Chemical Physiology at the University of Edinburgh. London: Edward Arnold & Co. New York: Longmans, Green & Co. Cloth; 5 x 7 in.; pp. 322; illustrated. $3.50.

APPLIED COLLOID CHEMISTRY: General Theory—By Wilder D. Bancroft, Professor of Physical Chemistry at Cornell University. New York and London: McGraw-Hill Book Co. Cloth; 6 x 8 in.; pp. 345; illustrated. $3.

Contrary to a general impression that colloids is a subject too highly theoretical to be readily grasped by the average engineering student, Professor Taylor's small volume presents the facts, theories and examples so clearly and concisely that it will hold the interest of readers not advanced in the knowledge of chemistry.

The book is a convenient text and an excellent reference book for workers in all branches of science. It defines colloids and crystalloids, not as different kinds of matter, but as different states of matter, and then describes the phenomena observed to take place when matter in the colloid state is treated in various ways. The deduction which has been made that colloids are an intermediate step between solids and true solutions is sufficient reason why they deserve the careful study of all scientists. They are particles either solid, liquid or gaseous, dispersed in liquids, gases or solids. At least one dimension of a colloid is very small so that the surface area for a given mass is correspondingly great. In these circumstances, forces of which we know little play major parts, overcoming the force of gravity and interfering with or aiding chemical reactions.

The volume outlines the general properties of colloids; gives selected experimental evidence for the theories set forth; describes the methods of preparation of various elements and matter in the colloid state; deals briefly with the phenomena incident to large surfaces and adsorption—which might be called the prime mover of colloids, as it is the force of attraction or repulsion between colloids and molecules that is consistently greater than gravity. Finally, the application of this branch of chemistry to the dyeing and tanning industries and to biology is pointed out as selected examples of the practical importance of the subject.

Students of concrete, water purification, sewage treatment, bacteriology and many other subjects will find in this book experimental facts analogous to phenomena encountered in their experiences and theories furnishing plausible explanations which will be helpful in guiding future investigations.

In the present edition, considerable new material has been added. This comprises either more convincing illustrations of already established theories or new experimental results which have led to changes in previously accepted theories. Professor Taylor's volume is valuable not only as a textbook, but also as a stimulus to investigation by those who must deal with matter in the colloid state.

Professor Bancroft's book is an interesting introduction to the chemistry of colloids and will be found valuable for reference. Every chapter contains information of interest to engineers that can be readily understood without advanced chemical training. A progressive thinker in almost any line of endeavor will discover facts and theories which will suggest new lines of investigation or furnish reasonable explanations of experiences that cannot be accounted for in the usual way.

More than one-third of the volume is devoted to the discussion of adsorption, which is the force of attraction or repulsion between liquids, gases and solids in their normal or colloid states. Adsorption of gas or vapor by solids—with resulting chemical reactions, in certain cases, of vapor by liquid and of liquid and solid by solid and liquid and adsorption from solution by solid and liquid—are clearly explained with reference to their practical applications in established industries or by accounts of reliable experiments. The remainder of the book describes surface tension and Brownian movements; coalescence and its reverse peptization; preparation and properties of colloidal solutions; gelatinous precipitates and jellies; emulsions, foams, fog and smoke, gases and solids in solids and thickness of surface films.

It is pointed out in the preface that this book on general theory should be followed by at least ten volumes adequately to set forth the colloid chemistry of the following subjects: Silicate industries; paints and varnishes; plastics; fibers and dyeing; photochemistry and photography; petroleum industries; ore flotation and allied subjects; foods and beverages; soils and crops; biology and medicine. But the present volume supplies the rudimentary principles essential to an understanding of cement, bricks, pottery, porcelain, glass, enamels; oils, greases, soaps, candles; glue, starch, and adhesives; paints, varnishes, lacquers, rubber, celluloid and other plastics; leather, paper, textiles; filaments, casts, pencils and crayons; ink; roads, foundry cores, coke, asphalt; graphite, patines; zinc, phosphorous, sodium, and aluminum; contact sulphuric acid; hardened oils, etc.; beer, ale and wines; cream, butter, cheese and caseine products; cooking, washing, dyeing, printing; ore flotation, water purification, sewage disposal; smoke prevention; photography; wireless telegraphy; illuminants; comets; pharmacy; physiology. This list is found in the introduction and is an incomplete statement of subjects commonly met in every-day life in which colloids play an important part.

Bridging a Gap

STRUCTURAL PROBLEMS, PART I—By C. R. Young, B.A.Sc., C.E., M.E.I.C., Associate Professor of Structural Engineering, University of Toronto. Second Edition. Toronto: Engineering Society of the University of Toronto. Paper; cloth back; 6 x 9 in.; pp. 96; line cuts.

For the young engineer there is apt to be a distinct gap between a piece of theory or an algebraic formula and its practical application in designing. Prof. Young shows a very serviceable bridge across this gap, so far as structural design is concerned. His manner of treatment makes the crossing of the bridge really a lesson in engineering, where formulas and theories are mere auxiliary aids in taking quantitative account of the physical facts of the case. By emphasizing in each of his design examples the assumption made antecedent to the calculation, Prof. Young compels his student-reader to think about the correspondence between the real columns, girders or frame and the ideal structures about which books on applied mechanics are written. Both steel and wood are dealt with in the little book. There is room for much more instruction in both fields, about details as well as about the larger structural elements. Possibly the further instruction is yet to come, as the present pamphlet is headed "Part I."

Basic Facts on Materials of Construction

MATERIALS OF CONSTRUCTION—Prepared for the Extension Division of the University of Wisconsin by H. E. Pulver, B.S., C.E., Associate Professor of Civil and Structural Engineering, the University of Wisconsin. New York and London: McGraw-Hill Book Co. Cloth; 6 x 9 in.; pp. 318; illustrated.

This is an accurate and adequate text prepared for correspondence school study. It is frankly elementary, but there is enough given to provide the student with the base facts regarding the manufacture and properties of the materials used in construction.

References on Fire Hazards and Resistance

The Municipal Reference Library of Chicago (Frederick Rex, librarian) has issued a "List of References on Fire Hazards and Fire Resistance of Office Buildings, Sky Scrapers and Fireproof Structures." It is also getting out occasional lists entitled "What Other City Councils Are Doing," consisting of brief notes on resolutions, ordinances, reports, etc., by city councils and executives.

Air—Refrigeration—Gas

A collection of illustrated papers and notes entitled "Air—Refrigeration—Gas" has been published separately in English, French and Spanish by the Verein Deutscher Ingenieure, Berlin, Germany. The main subjects treated, each by a different author, are piston compressors, turbo compressors and blowers, fans, locomotives, air drills and hammers for mining, pneumatic tools, refrigeration and air liquefaction and separation.

State College of Washington Bulletins

Three recent Engineering Bulletins of the State College of Washington (Pullman) are: "Well and Spring Protection," by M. K. Snyder; "Water Supply for the Country Home," by Mr. Snyder and H. J. Dana; "The Use of Ropes and Tackle," by Mr. Dana and W. A. Pearl. All are illustrated.

PUBLICATIONS RECEIVED

[When possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated. Many of the pamphlets can be obtained without cost, or by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain any publication listed should apply for information to the stated publisher, or, in case of books or papers privately printed, then to the author or other persons indicated.]

New Books and Revised Editions

ENGINES AND BOILERS—By Thomas T. Eyre, Dean, College of Engineering, State University of New Mexico; Formerly Assistant Professor of Mechanical Engineering, Purdue University. [Engineering Science Series.] New York: The Macmillan Co. Cloth; 6 x 9 in.; pp. 234; line cuts. $3.50.
Designed for "an elementary course in heat engines"; based largely on lecture and mimeographed notes used by the author at Purdue University. Representative problems are given.

GUILD SOCIALISM: An Historical and Critical Analysis—By Niles Carpenter, Ph.D., Instructor and Tutor in Social Ethics in Harvard University. New York and London: D. Appleton & Co. Cloth; 6 x 9 in.; pp. 350. $2.50.

THE HYDRAULIC PRINCIPLES GOVERNING RIVER AND HARBOR CONSTRUCTION—By Curtis McD. Townsend, Colonel, United States Army (Retired), M. Am. Soc. C. E., Late President Mississippi River Commission. [Engineering Science Series.] New York: The Macmillan Co. Cloth; 6 x 9 in.; pp. 189; 5 line cuts. $2.60.

OFFICIAL SOUTH AFRICAN MUNICIPAL YEAR BOOK, 1922—Joint Editors: W. P. M. Henderson, Formerly Town Clerk of Durbar; Francis G. Pay, Cape Town. London: Edw. G. Allen & Son, Ltd. Cloth; 6 x 10 in.; pp. 412. 25s.
Besides giving a general description of each of the municipalities and their activities, together with their principal officials, this volume contains tables of comparative statistics, including light and power, municipal debts and other finances, water supply, fire protection and public libraries.

PHYSICAL AND CHEMICAL EXAMINATION OF PAINTS, VARNISHES AND COLORS—By Henry A. Gardner, Director Scientific Section, Educational Bureau, Paint Manufacturers Association of the United States; National Varnish Manufacturers Association, Co-operating. Washington, D. C.; P. H. Butler, Sales Agent, 1845 B St., N.W. Cloth; 6 x 9 in.; pp. 219+ various circulars of the U. S. Bureau of Standards—halftones and line cuts. $9.

RAILWAY ELECTRIC TRACTION—By F. W. Carter, M.A., M. Inst. C. E., M.I.E.E., Assoc. A.I.E.E. New York: Longmans, Green & Co. London: Edward Arnold & Co. Cloth; 6 x 9 in.; pp. 412. $8.50 net

SHIELD AND COMPRESSED AIR TUNNELING—By B. H. M. Hewitt, M. Am. Soc. C.E., M. Inst. C.E., Director, Jacobs & Davies, Inc., New York, Consulting Engineers, sometime engineer on the construction of the Central London Railway, of extensions to the City and South London Railway, of the Hudson River Tunnels for the Pennsylvania R.R., New York, and of the Laxaxalpam Aqueduct Tunnels for the Mexican Light & Power Co. in the State of Puebla, Mexico; and S. Johannesson, M. Am. Soc. C.E., sometime engineer on the construction of the Islington extension to the City & South London Railway, of the Pennsylvania Railroad Tunnels, New York, and of the Manhattan Elevated Railroad improvements and extensions for the Interborough Rapid Transit Co., New York. New York and London: McGraw-Hill Book Co., Inc. Cloth: 6 x 9 in.; pp. 465; $5.

SIX YEARS IN BOLIVIA: The Adventures of a Mining Engineer—By A. V. L. Guise. New York: E. P. Dutton & Co. Cloth; 6 x 9 in.; pp. 243; half tone plate. $7.

THE WELDING ENCYCLOPEDIA: A Practical Reference Book on Autogenous Welding—Compiled and Edited by L. B. Mackenzie and H. S. Card of the Editorial Staff of the *Welding Engineer*. Chicago: The Welding Engineer Publishing Co. Flexible; 6 x 9 in.; pp. 388; 550 illustrations. $5.
Materially enlarged from first edition.

Reports and Pamphlets in Various Fields

FOREST PRODUCTS: Census of the United States, Manufacturers, 1919—Paper; 10 x 11 in.; pp. 84. Washington, D. C.: Bureau of the Census.

QUEBEC STREAMS COMMISSION: Report for 1920-21—Quebec, P.Q. Paper; 6 x 9 in.; pp. 112; diagrams.

RAMSHACKLE COUNTY GOVERNMENT: The Plague Spot in American Politics. By Richard S. Childs. New York: National Municipal League, 261 Broadway. Paper: 4 x 6 in.; pp. 27; 1 diagram. 10c.; $5 per 100.
A revision of Mr. Child's snappy exhibit of what has been called the weakest spot in American government today.

SAMPLING AND ANALYSIS OF PIG IRON: Methods of the Chemists of the United States Steel Corporation—[J. M. Camp, Chairman, Chemists' Committee.] Paper; 6 x 9 in.; pp. 40; line cuts.

STATISTICAL ABSTRACT OF THE UNITED STATES, 1921—Compiled by Edward Whitney. Cloth; 6 x 9 in.; pp. 942. 75c. from Superintendent of Documents, Washington, D. C.

STATISTICS OF COMMON CARRIERS: Preliminary Abstract of 1921 Report. Washington, D. C.: Interstate Commerce Commission. Paper; 9 x 12 in.; pp. 30. 5c. from Superintendent of Documents, Washington, D. C.

TESTS OF JOINTING MATERIALS FOR VITRIFIED CLAY PIPE—By S. E. Dibble, College of Industries, Carnegie Institute of Technology, Pittsburgh, Pa. Also Report of Bureau of Surveys, Philadelphia, Pa. Issued by Eastern Clay Products Association, Philadelphia, Pa. Paper; 8½ x 11 in.; pp. 15. The first part consists of brief summaries of tests of "compound" jointing material (largely bituminous) and of cement mortar and neat cement, under a variety of conditions. The Philadelphia report deals entirely with bituminous jointing material.

WATER POWER AND STORAGE POSSIBILITIES OF THE HUDSON RIVER: Report of New York Water Power Commission. Prepared Under Direction of Frank M. Williams, State Engineer and Surveyor, Member and Secretary of Commission, by E. H. Sargent, Senior Assistant Engineer. Paper; 6 x 9 in.; pp. 75; illustrated, including map diagrams, and half tones. Continuation of investigations previously made by Conservation Commission. Describes various possible reservoirs; also power developments both actual and possible. Contains tables and diagram of gagings.

WATER SUPPLY INSTALLATIONS FOR FARMSTEADS AND COUNTRY ESTATES—By William Paul Gerhard, C.E., Dr. Eng., Consulting Engineer. Published by the Author, 17 W. 42nd St., New York City. Paper; 6 x 9 in.; pp. 24. 40c.

WISCONSIN STATE PLUMBING CODE—(Fourth Edition). Madison, Wis., State Board of Health. Paper; 5 x 7 in.; pp. 204.
Besides the State Plumbing Law of 1913, and the State Board of Health Plumbing Regulations, the pamphlet contains a variety of useful information on water supply and sewage disposal for houses, etc., including sketches with explanatory matter.

LETTERS TO THE EDITOR

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

To Prevent Theater Accidents

Sir—With the Strand theater accident Pittsburgh has been again shocked and grieved and made to realize the futility of impersonal and thinly distributed responsibility. A very bad type of design, and one that invited deterioration in several distinct ways, is the cause of this disaster. Wooden joists projecting 2 in. into a brick wall; 5 in. of plain concrete over these joists, with its great dead weight and its impervious character; an enclosed, unventilated, unpaved and unused cellar, which furthermore was very damp and is said to have been frequently flooded; these are the things that brought on an almost total destruction by wet rot in the short period of eight years.

Of course we will have the usual "rigid investigation" and the usual formal placing of responsibility which will not remain placed. The usual farce will be enacted while the public is forgetting about it. Some clerk will doubtless be sent to each theater to ask the proprietor if his building is safe and maybe to see if it has doors enough to let enough people in to fill it quickly.

A real examination of this building and of the Majestic theater, which collapsed a few months ago, could not fail to have disclosed to a structural engineer the absolute danger of using either.

What is needed is an ordinance or a public demand that all public buildings be examined by a responsible structural engineer and that a notice be posted signed by this engineer—his personal signature—stating that the building is safe. We have had quite enough of bureau inspection rubber-stamped by one of the drawers (of salary) of the bureau.

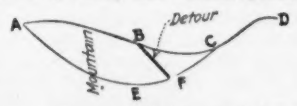
EDWARD GODFREY.

Pittsburgh, Sept. 26.

Meditations on Detour Practice by an Autoist

Sir—As one motors day after day through various states over roads good, bad, and indifferent, with unheralded and unchartered detours, he is apt to ponder whether, after all, he is not mistaken in assuming that the function of a highway is to furnish ease of transportation.

If the routes of detours were plainly marked it would facilitate the journey. Too often one is turned loose on a detour and must needs negotiate it as best he can. Next, there should be sufficient maintenance of the detour to keep it in passable condition. The detours are often over unimproved roads and, even though they carry the normal traffic with fair efficiency, when the heavier traffic is turned over them they soon become very bad. There is no excuse for allowing these roads to have entirely across them such deep ruts that cars drag on the ridges.



There should be also readily accessible data on detours so that before starting on a route a person may know what is ahead of him and not proceed on a main road only to be deflected, without previous warning, over an atrocious side road. One method of accomplishing this result would be to have the information in regard to detours posted at the beginning of a route *A*, giving the points between which the detour is, with information in regard to the character of the detour. In many cases it would then be possible, in going from *A* to *D*, to take another route where the road would be good and the distance not much greater. In many cases it would be preferable to take the other route at a considerable increase in distance when taking into account time, wear and tear on the automobile, and the amount of gas used.

As illustrated by the sketch one could go from *A* through *E* to *F*, instead of through *B* to *F* where *B-F* is very poor, at an increase of only ten miles in distance. Further the road from *A* to *B* passes over a mountainous road with high grades, whereas from *A* to *E* the route is through a notch with very gentle descending grades. On the reverse route, from *D* to *A*, full information should be given at *F* in regard to the routes *F-B-A* and *F-E-A*. In general, information in regard to detours should be more easily accessible before the point of detour is reached.

More care should be used not to place signs in regard to construction or repairs until they are needed and to remove them when the work is finished. In one state a road was encountered with a sign on the left "No passing, Bridge up." On the right was the warning "Construction, Unsafe but Passable." Having experienced several instances in that state where the road construction was completed but the "Unsafe but Passable" sign was left in place, doubt was had as to the advisable procedure. However as the "Bridge Up" sign looked fairly new it was decided to take the detour. Often also the roads might be left open while under construction. In another state a concrete road had a "No Passing" sign. Inquiry at a nearby house elicited the information—"Cars all go through and none come back." This road was in good condition. The only evidences of construction were a pile of gravel and a small piece of machinery on the shoulder at the end of the road.

In another state where work was in progress inquiry was made as to the character of the detour. The official questioned replied—"It is a very bad detour but I guess you can get through." While looking over the car to make sure that everything was in good condition another car was seen to stop. Shortly the informer in regard to the detour came up and said,—"See that car. That is a highway official. He is going over the main road. If he can, you can. Follow him." This advice was heeded and the trip was made in comfort.

CHARLES A. HOLDER,
Director, Thayer School of Civil Engineering.

Hanover, N. H., Aug. 19.

Coal-Bin Pressures

Sir—In connection with the article "Some Data on the Design of Steel Coal Bins," by R. Fleming, in *Engineering News-Record* of Aug. 31, p. 346, I should like to comment upon the theories used to obtain the lateral pressures.

Table I, p. 348, is based upon a wedge theory which assumes that the plane of rupture bisects the area between the wall, the plane of repose and the surface of the fill. This result was given by Rebhann (1870) and later elaborated by Weyrauch (1878), who is also responsible for the "pressure triangle," (DFE in Fig. 3). Since the theory is based upon an undisturbed granular mass beyond the plane of repose, and a balanced mass at rest between the planes of repose and rupture, it does not apply to the case of bins. Had the author drawn the plane of rupture from both sides of the bin, he would have noticed that a certain portion of the material tends to exert pressure on both sides of the bin at the same time, so that neither side is acted upon by the effect of a complete wedge. A better, but still not perfect, theory for the case of a bin was developed by Woltmann (1799), who takes into account the simultaneous pressure on both sides of the bin and also the frictional resistances on both walls.

The diagram in Fig. 3 shows the resultant inclined at an angle of 30 deg. to the horizontal. It is doubtful whether the angle of friction of coal on steel ever reaches 30 deg.; the author mentions that Dull had taken 16 deg. for anthracite and 18 deg. for bituminous.

The use of an equivalent-fluid method is theoretically unsound and has been experimentally proven incorrect. Granular materials, especially of the size of coal, do not obey the laws of liquids. For example, how can we consider the condition of coal piled up at the top surface if we

assume the coal to act as a liquid and even give it an equivalent liquid density?

The theories of Rebhann and Weyrauch are most easily accessible in Prelini's "Graphical Determination of Earth Slopes, etc." (1908). Woltmann's theory may be found in his "Hydraulischen Architektur" or in Hagen's article on "Untersuchungen ueber den Druck des Sandes" in *Annalen der Physik und Chemie* (1833), Vol. 116, pp. 17 and 217.

From Table I the writer notes that, evidently, the width of the bin has no effect upon the lateral pressure if the surface of the fill is horizontal. However, even for a height of 2 ft., in the case of sloped fills, an increase in width for all widths results in an increase in pressure. The value for a 15 ft. width, 57, which is greater than for the 20 ft. width, 54, is probably an error. There is no theoretical or experimental foundation for any variation after the width is sufficient to give a full plane of rupture from each side. However, if we assume that the material acts like a liquid, the width should have absolutely no effect upon the pressure; the pressure should be the same whether the walls are an inch or a mile apart. JACOB FELD.

Brooklyn, N. Y.
Sept. 16.

Rapid Sand Filter Plant in the Far East

Sir—In the article on "Waterworks and Filtration Plant for Dairen, Manchuria," appearing on p. 244 of your issue of Aug. 10, this recently installed plant is described as the "first rapid sand filter plant in the Far East."

Six years ago a rapid filtration plant of 8,000,000 g.p.d. was installed for Kobe City, the contract being placed through Mitsui & Co., with the Paterson Engineering Co., Ltd., of London, who supplied the whole equipment for metering and coagulant supply gear, sedimentation tanks, twelve 24 x 12 ft. Paterson gravity filter units, constructed in reinforced concrete, with pure water storage tank below, and electrically driven auxiliary machinery, etc.

The plant has been in operation for the past six years with consistently satisfactory results, and what is practically a duplicate plant is now being installed at Fushun, Manchuria. O. C. KERRISON.

London, Eng., Sept. 22.

Return Water From Wyoming Streams

Sir—In *Engineering News-Record*, July 20, 1922, p. 105, R. I. Meeker calls attention to the very important part that return water plays in irrigation, especially in the older settled regions of the West. This phenomenon is emphasized by results obtained on streams in Wyoming.

During the summer of 1920 the U. S. Geological Survey in co-operation with the state engineer, conducted a series of measurements on streams in the Big Horn Basin and the northeastern section of Wyoming to determine the amount of return water. The work was described in detail in the fifteenth biennial report of the state engineer, but no comparisons were made between diversions and return water.

The streams selected were those on which irrigation had been practiced since the early eighties and where the majority of ditches were completed prior to 1900. So extensively are these streams utilized that in dry years an acute shortage of water occurs. The streams have a fall ranging from 30 to 65 ft. per mile with an average of about 45 ft. In Big Horn Basin the land irrigated is chiefly bottom land, which forms a comparatively narrow strip along the streams. Land irrigated from Greybull River, however, comprises many thousand acres of so-called bench land lying above the river bottoms. In the northeastern section irrigation has reached a higher stage of development than in the Big Horn Basin and a large part of the area irrigated is bench land.

The accompanying table shows the percentage of return water to total diversion in the different streams investigated together with the total discharge of the streams. So important is the return water that in about half the series given in the table, the total diversions are greater than the discharge of the stream at the head of the irrigated section plus the flow of tributary streams below.

SUMMARY OF RETURN WATER IN WYOMING STREAMS

Stream	Length of Stream Investigated, Miles	Dates of Measurement	Discharge of Stream at Head of Section+Tributary Flow, Sec.-Ft.	Diversions, Sec.-Ft.	Return Water, Sec.-Ft.	Per Cent of Return Water to Diversions
Big Horn Basin						
Owl Creek	38.0	Sept. 6–7, 1920	14.5	12.0	— 7.8	
No Wood Creek	33.5	July 27–28, 1920	281	47.3	41.5	88
Tensleep Creek	6.0	July 26, 1920	223	57.6	12.7	
Paintrock Creek	13.5	July 23–24, 1920	278	110	—14.0	
Paintrock Creek	13.5	Aug. 24–25, 1920	68.8	52.1	17.3	33
Medicine Lodge Creek	6.1	July 21–22, 1920	42.5	66.0	24.7	37
Medicine Lodge Creek	5.6	Aug. 25, 1920	26.2	50.3	21.0	42
Shell Creek	16.8	Aug. 15–16, 1918	112	103.4	46.6	45
Shell Creek	16.8	Sept. 1, 1918	100	121.7	50.1	41
Shell Creek	16.8	June 30, July 1, 1919	83	111.7	42.4	36
Shell Creek	16.8	July 29, 1919	58	80.8	19.8	24
Shell Creek	20.4	July 22–24, 1920	145	155.4	48.5	31
Greybull River	66.0	Aug. 30, Sept. 2, 1920	174	203	23.6	12
Wood River	10.0	July 30, 1920	171	27.4	22.4	82
Wood River	13.2	Aug. 30, 1920	70	32.3	30.2	94
Northeastern Section						
Little Goose Creek	16.8	Aug. 18, 1920	41.2	85.4	56.9	67
Little Goose Creek	16.8	Sept. 11, 1920	34.9	47.2	28.7	61
Clear Creek	42.4	Aug. 12, 15, 1920	122	126	44.2	35
Clear Creek	42.4	Sept. 20, 21, 1920	70	38.1	17.5	46
Rock Creek	13.1	Aug. 13, 1920	72	58.6	0.0	0
Rock Creek	13.1	Sept. 18, 1920	11.2	7.9	3.6	46
French Creek	8.9	Aug. 11, 12, 1920	49.6	68.7	23.7	35
French Creek	7.3	Sept. 17, 18, 1920	13.3	12.0	5.4	45
Piney Creek	22.0	Aug. 17, 1920	59	56.3	18.5	33
Piney Creek	22.0	Sept. 14, 15, 1920	41.6	20.9	5.3	25
North Piney Creek	3.5	Aug. 16, 1920	106	97.6	11.6	12
North Piney Creek	4.0	Sept. 13, 1920	60	28.4	1.1	34
South Piney Creek	2.5	Aug. 16, 1920	136	115	20.6	18
South Piney Creek	2.5	Sept. 14, 1920	43	38.8	11.5	30

ROBERT FOLLANSBEE,
District Engineer, U. S. Geological Survey.

Denver, Colo.,
Sept. 20.

Possibilities of "Sacramento" Aerator Nozzles

Sir—The "Sacramento" floating-type of aerator nozzle described in *Engineering News-Record*, Sept. 7, p. 384, offers the interesting possibility of arranging influent piping to slow sand filters so that the raw water can be aerated in the space between the water line of the filters and the under side of the covers, thus making it possible to aerate even in the coldest weather and to combine the control of aeration and filtration under one roof at probably a minimum of expense for construction and operation.

F. B. MARSH,
Designing Engineer,
Providence Water Supply Board.

Providence, R. I.

Labor Costs and Conditions in Mesopotamia

Sir—The readers of *Engineering News-Record* may be interested to learn of the great difference of labor costs that exist between the United States and the Middle East.

In Mesopotamia (or 'Iraq as it is now to be called) "common labor" costs 14 annas a day of 8 hours. At the present rates of exchange the rupee (16 annas) is equivalent to 29c., so that the laborer or coolie commands a salary of 25½c. per day. The New York laborer appears to receive 11 to 14 times as much, though he does about five times as much work.

An Arab bricklayer receives 75 to 87c. a day, and can lay about 300 bricks in a simple wall, in 8 hours.

Women and children do useful small jobs, and well earn 18 and 10 cents a day respectively.

In Baghdad, 350 miles north of Basrah, the rates are nearly 50 per cent higher. The following types of coolies are obtainable: Persians (of a very low caste, having extremely small intelligences) who are useful for carrying loads, Arabs who are physically much finer and more active, but who take some driving, Kurds and also Armenians, the latter being Christians and almost European in appearance.

H. C. LOTT,
Deputy Director of R. E. Services.

Basrah, 'Iraq, Aug. 22.

NEWS OF THE WEEK

New York, October 19, 1922

President Names Federal Coal Commission

Authorities on Technical, Social and Economic Problems of Industry Compose Fact-Finding Body

Washington Correspondence

The President on Oct. 10 announced his selections for the federal commission which will make an exhaustive study of the problems of the coal industry. The commission will consist of John Hays Hammond, mining engineer; Thomas R. Marshall, vice-president during the Wilson administration; Samuel Alschuler, judge of the circuit court; Clark Howell, editor of the *Atlanta Constitution;* George Otis Smith, director of the U. S. Geological Survey; Edward T. Devine, writer on social and economic questions; and Charles P. Neill, formerly member of the board of adjustment for labor disputes under the Erdman Act.

The commission will meet for organization purposes on Oct. 18. While Mr. Marshall and Dr. Smith each has been mentioned for the chairmanship, it is believed that this will go to Mr. Hammond.

Practically all comment on the personnel of the commission is favorable. It very generally is regarded as a good blend of conservative and liberal opinion. Perhaps never before has any investigation of coal by a federal agency started with so little prejudice. It has the great advantage of having a personnel which is not in any way interested in making political capital out of its fact-finding activities and in this way differs greatly from the efforts of several congressional investigating committees.

Individual Qualifications

As to special qualifications of the commission members the following may be said: Mr. Hammond has been linked prominently and intimately with the mining industry for so long that it is regarded as very fitting he should participate in what is expected to be one of the most important steps taken in connection with coal in recent years. Dr. Smith for many years has made coal the study to which he has devoted most of his personal attention. It is believed that Mr. Neill has the confidence of both operators and mineworkers. It is conceded that he knows more than anyone else, outside of the coal business, as to the conduct of collective bargaining in that industry. Mr. Marshall is nationally known as a friendly type of philosopher with a real sense of humor and possessed of a general desire to ascertain honestly the other man's point of view. Judge Alschuler has given many indications of judicial balance and a sense of fair play. He is best known to the coal industry for his part in refusing to sustain Judge Anderson's check-off injunction. Mr. Howell is a southern editor: conservative and accustomed to pass dispassionately on questions of great moment. Mr. Devine has that characteristic of good will and friendliness which seems to run through each of the members of the commission.

It is expected fully that the commission will appoint a fairly large staff of specialists who know how to collect coal information and put it together and that it will hold as few formal hearings as possible, gleaning its information rather through intimate contact with those who are acquainted with the industry.

Renew Alabama Power Lease at Muscle Shoals

Announcement has been made by Secretary Weeks of the War Department that the lease under which the Alabama Power Co. operates the government steam-electric plant at Muscle Shoals, Ala., has been renewed for another year. This has been done because of the exigencies of the demand for manufacturing in the South and the improbability of early settlement of the future of the Muscle Shoals plant.

New York Merchant's Association to Study Transit Plans

Pursuant to a report of its committee on city traffic, the Merchant's Association of New York has made an appropriation for the study of the two transit extension plans recently proposed by the Transit Commission and by Mayor Hylan. The investigation will be directed by Col. Frederic A. Molitor, chairman of the committee on city traffic. An expenditure of $2,500 has been authorized for engineering and other assistance that may be required.

New Development by Alabama Power Company

The Alabama Power Co. has applied to the Federal Power Commission for a preliminary permit covering a project for the development of 60,000 hp. of primary power on the Tallapoosa River in Elmore, Randolph, Chambers and Tallapoosa Counties of Alabama. The construction of four dams is proposed. Ten miles above Tallahassee, Ala., it is planned to erect a dam 110 ft. high at Cherokee Bluffs. Another dam would be located five miles from Alexander City, just below the mouth of Rigby Creek. This dam will be 85 ft. high. The third dam would be erected at a point on the river ten miles north of Dadeville. Its height will be 60 ft., according to the estimate submitted to the commission. The upper dam is to be just above the mouth of Crooked Creek, a few miles below the junction of the Tallapoosa and the Little Tallapoosa Rivers. That structure will have a height of 150 ft. It is understood that the company plans the full development of this project within a period of ten years.

To Hold Highway Education and Transport Meeting

Conference To Take Place at Washington Under Direction of Highway Education Board

An attendance of approximately 400 is expected at the second annual Conference on Education for Highway Engineering and Highway Transport, which will be held in Washington Oct. 26, 27 and 28 under the auspices of the Highway Education Board.

The object of the conference, as set forth in the official announcement, is, "to review the field of highway engineering and highway transport education in the light of the expanding State and federal highway program and the rapidly increasing social and commercial use of the highways; to discuss general and special courses in undergraduate and graduate curricula; and to exchange views on educational trends arising from these developments in the national transportation system."

List of Speakers

Among the speakers will be T. H. MacDonald, chief of the Bureau of Public Roads; A. J. Brosseau, president, Mack Brothers Motor Car Co.; T. H. Agg, professor of highway engineering, Iowa State College; Arthur H. Blanchard, professor of highway engineering and highway transport, University of Michigan; C. J. Tilden, professor of engineering mechanics, Yale University; Lewis W. McIntyre, assistant professor of civil engineering, University of Pittsburgh; George H. Graham, vice-president, Chandler Motor Co.; Roy D. Chapin, president, Hudson Motor Car Co.; Dr. W. K. Hatt, director, advisory board on highway research, National Research Council; Alvan Macauley, president, Packard Motor Car Co.; Dr. Charles S. Howe, president, Case School of Applied Science; Charles J. Bennett, State Highway Commissioner of Connecticut; Dr. F. L. Bishop, dean, school of engineering, University of Pittsburgh, and others whose definite acceptance of invitations is being awaited.

Ten special committees will submit reports, which will be discussed at the conference, on these subjects: required and elective undergraduate subjects in highway engineering; required and elective undergraduate subjects for highway transport business and engineering positions; subject matter of basic required undergraduate course in highway engineering; subject matter of basic undergraduate course in highway transport; subject matter of undergraduate course in highway engineering theory and design; subject matter of undergraduate course in highway engineering laboratory; nature and content of supporting non-technical courses in economics and English; graduate work in highway engineering and highway transport; conferences or short courses on highway engineering and highway transport; teaching highway traffic regulation and safety.

Street Sanitation Men Exchange Experiences

nternational Association Officials Discuss Problems at Chicago Meeting

A definite trend toward garbage incineration, toward motorization of street cleaning equipment, toward restriction of automobile parking after midnight to permit streets to be swept or flushed, and toward the use of eductors for cleaning catch basins, was noted at the third annual conference of the International Association of Street Sanitation Officials which met Oct. 9 and 10 in Chicago. The meeting was strictly a conference, with round table discussions which drew out the experience and opinions of the city officials. No addresses or papers were presented. The second day was given over to an inspection of the equipment and methods of street cleaning and garbage disposal in Chicago.

Garbage Problems

On garbage problems the following salient points were brought out: St. Louis is building and about to test the first of a series of four 100-ton high-temperature, forced-draft incinerators guaranteed to burn the garbage for $1 per ton with a maximum of 140 lb. of coal; motors and trailers have cut costs of collection from $5 to $2; Minneapolis is still using two 20-year old and one 10-year old incinerators requiring 70 to 140 lb. of coal per ton of garbage but the engineers do not consider the production of steam a commercial practicality, as at one time heralded; and tractors and trailers have reduced the odor nuisance due to collection.

Chicago finds that the disposal of dead animals costs $57,500 annually now instead of yielding a revenue of $5,000 as formerly. The number of dead animals handled has decreased from 6,570 in 1917 to 3,735 in 1921. Boston's reduction plant is being studied by George A. Johnson, consulting engineer. Newark's hog-feeding contract was in financial straits until the city advanced $25,000 which was secured by retaining title to 2,000 hogs. Joplin, Mo., compels the hotels to care for the town's garbage for the privilege of hauling their own rich wastes to their own piggery. On Erie's hog farm 1,200 hogs eat 60 to 70 tons daily.

As to the effect of traffic on street sanitation work the following was reported: Chicago finds that night parking seriously interferes with flushing. Minneapolis and St. Louis have ordinances prohibiting parking in congested districts after midnight unless the automobile is accompanied by a chauffeur to move it for the cleaners.

Automotive Equipment Use

Automotive equipment is growing rapidly. Detroit, with its 250 trucks and 350 passenger cars in a motor transport department, has begun standardization of equipment, keeps elaborate accounts such as mileage per gallon and costs per mile on each vehicle and rents out equipment to other departments. It operates on a $100,000 revolving fund and makes money, though its charge for cars is 50c. per hour less and for trucks $2 per hour less than the prevailing rate. It is building one of the largest garages in the country, 7 acres, for which $750,000 is available, plus $230,000 for the site.

Chicago, like most cities, is floundering over the question of control of heavy truck traffic, said F. H. Cenfield. St. Louis has recently designated major streets for all traffic and minor streets from which trucks are excluded. It has twenty-five plain clothes inspectors to enforce the traffic ordinances.

Catch basin cleaning by eductors in Newark costs $3.14 against $5.02 by hand. The machine cost includes interest, a 20 per cent annual depreciation, repairs and maintenance. In St. Louis eductor cleaning costs $1.50 to $2 and hand cleaning, $3 to $5. Mr. McGrath, Chicago, superintendent of sewer cleaning, said that cleaning sewers by a machine of the eductor type offered a field for the inventor and manufacturer. He exhibited a reversible rim catch-basin top in three pieces which eliminates tearing up the pavement when the ring needs replacement. The assembly weighs 80 lb. less than the one formerly in use.

Motor driven flushers in Chicago will be augmented by ten each year for the next five years, said W. J. Galligan, Bureau of Streets, Chicago, who favors the double-unit type. Minneapolis pins its faith on sweepers and does half as much flushing as formerly. Joplin has discontinued flushers.

The officers elected for 1922 are as follows: W. J. Galligan, president; Abram Swan, O. B. Mahoney, W. J. Walsh and Theodore Eichorn, vice-presidents; A. M. Anderson, Chicago, secretary.

General Connor Goes to China

Brig.-Gen. William D. Connor, U. S. A., a former Corps of Engineers officer, and who has been serving as Assistant Chief of Staff of the War Department, has been ordered to the command of the American troops in Tientsin, China. The relief of Col. William F. Martin, in command there, is believed due to the increasing political importance of the post and the necessity of having a man in command with a rank higher than that of colonel.

General Connor is a graduate of the Military Academy with the class of 1897, having finished at the head of his class. After graduation he served under Major W. L. Fiske in the Department of the Columbia, later actively engaging in the siege and capture of Manila during the Spanish-American War. After that war he was in charge of water-works and water supply of the City of Manila, and later served as city engineer. Other military engineering assignments include design and construction of seacoast batteries in Connecticut, instructor in civil engineering at the Military Academy, student officer at the Army Staff College, in charge of the 1st and 2nd districts of the Mississippi River Improvement, in charge of the U. S. Engineers' Office at Little Rock, and in command of engineer troops. At one time he was managing editor of *Professional Memoirs*, now *The Military Engineer*.

General Connor left the Corps a number of years ago for general staff duty. During the World War his chief assignment was Chief of Staff to Major-General Harbord.

Dr. S. W. Stratton Heads M.I.T.

Washington Correspondence

Dr. S. W. Stratton, for twenty-one years director of the Bureau of Standards of the Department of Commerce, has resigned to become president of the Massachusetts Institute of Technology.

As the director of the Bureau of Standards, Dr. Stratton built up an institution. He took over the directorship of the Bureau when it was created in 1901. The Bureau sprang from a division in the Coast and Geodetic Survey concerned with the standardization of weights and measures.

The Bureau of Standards was intrusted during the first year of its existence with the expenditure of an appropriation of $200,000. From that small beginning Dr. Stratton was able to build up a great scientific laboratory which has been intrusted with the expenditure of more than $2,000,000 on a year's work. Under Dr. Stratton's direction, the Bureau has grown until it is the largest physical laboratory in the world, and employes more specialists in research than any other single agency in this or any other country.

Those who have worked for many years with Dr. Stratton declare his strongest point is his ability to direct the work on a large number of diversified technical problems in a way so as to insure maximum results. Despite the widely varying character of the experimentation conducted by the Bureau of Standards, Dr. Stratton's associates declare that he always has kept abreast with the work and invariably could be relied upon for a practical suggestion as to its conduct. He is credited with being particularly apt in recognizing when sight was being lost of the objective and the work being allowed to proceed along a tangent.

Dr. Stratton was born in Litchfield, Ill., July 18, 1861. He received his B. S. degree at the University of Illinois in 1884 and his D. Sc. from the Western University of Pennsylvania in 1903. He was an instructor in mathematics, physics and electrical engineering at the University of Illinois from 1885 to 1892, and an instructor in physics at the University of Chicago from 1892 to 1901. In that year he assumed his duties as Director of the Bureau of Standards.

In connection with Dr. Stratton's resignation, Secretary of Commerce Hoover issued a statement condemning the "desperately poor pay" allowed scientific and technical men by the government. He pointed out that the Massachusetts Institute of Technology, an educational institution, has no difficulty in paying men of Dr. Stratton's caliber three times the salary which the government allows them. "The inability of scientific men in the government to support themselves and their families properly under the living conditions in Washington," said Secretary Hoover in his statement, "and to make provision for old age, makes it impossible for any responsible department head to secure such men for public service at government salaries."

Dr. Richards Installed as Head of Lehigh University

Dr. Charles Russ Richards, former dean of the college of engineering at the University of Illinois, was inaugurated president of the Lehigh University, Bethlehem, Pa., Oct. 14. The inauguration was part of the Founder's Day program and a tea and dinner to Dr. and Mrs. Richards were parts of the ceremonial. Dr. Richards is a graduate of Purdue University where he received his bachelor's and master's degrees in mechanical engineering. He took his doctor's degree at the University of Nebraska in 1920. For twenty years Dr. Richards was on the faculty of the Colorado Agricultural College as professor of mechanics, mechanical engineering, associate dean of the Industrial College in charge of all engineering; and then as dean of the Engineering College. In 1911 Dr. Richards was appointed professor of mechanical engineering at the University of Illinois. Two years later he became acting dean of the College of Engineering of that institution and acting director of the Engineering Experimental Station, and in 1917 was made dean and director. He is a member of the American Society of Mechanical Engineers, the Western Society of Engineers and the Society for the Promotion of Engineering Education.

Irrigation Division of Am. Soc. C. E. Now Being Formed

At a meeting of about thirty members of the Am. Soc. C. E. held during the recent fall meeting of the Society in San Francisco it was agreed to form an irrigation division of the Society. This will be done in accordance with the plan for divisions adopted at the Portsmouth meeting last spring.

The signatures of twenty members which are necessary for the formation of a new division were assured from those present at the San Francisco committee meeting and completion of the plan is only a matter of carrying out the prescribed form. A committee appointed to formulate the organization consists of T. H. Means, C. E. Grunsky and B. A. Etcheverry, all of San Francisco.

Landis Award Committee Is Operating Trade School

For some time the Citizens Committee to Enforce the Landis Award in Chicago has maintained a trade school for plumbers. It has recently employed C. L. Bailey, a trade school organizer from Cincinnati, to enlarge the school. Five classes are to be started at once; sheet metal work, carpentry, painting and decorating and blueprint readings. The courses are not confined to men already at work on Landis Award jobs but are intended for boys recommended by contractors. At first, however, the men at work will probably make up the bulk of the membership.

The Engineer in Public Life

A. M. LOCKETT

The Civitian Club of New Orleans, a national organization with local chapters similar to the Rotary and Kiwanis clubs, has an engineer for its president in the person of A. M. Lockett, president of A. M. Lockett & Co., Ltd. In this post he is in close contact with the civic and business affairs of the city. This contact is further strengthened by membership in the New Orleans Association of Commerce, of which organization he has served as a director and also as chairman of several important committees.

When the governor of Louisiana was called upon recently to appoint a Board of Commissioners of the Port of New Orleans, Mr. Lockett was named as one of the six members and elected as vice-president of the board, which has entire charge of the business management of the port. The members of the board serve without compensation. Mr. Lockett is known locally as an able and public-spirited man who is engaged in a number of activities in addition to his engineering work. He has always displayed interest in any question of civic betterment and among other duties has served as director of a municipally controlled trade school at New Orleans. He is a member of the Louisiana Engineering Society, the American Society of Mechanical Engineers, and other technical organizations.

Montana Makes Route Survey as Road-Building Preliminary

The Montana Highway Department during October is undertaking a route and condition survey of its entire 7 per cent or trunk-highway system comprising approximately 4,700 miles of road. This survey is being conducted under the immediate supervision of the ditrict engineers of which there are four. The survey will determine with-reasonable limits the location of all future construction with federal aid and will indicate the urgency of construction in various parts of the state. From the information obtained a three-year construction and maintenance program will be worked out by the department during the winter months. It is expected that the survey will be complete by Nov. 1 The work is under the general supervision of John N. Edy, chief engineer.

Wenatchee Yard of G. N. Ready

Construction of the Great Northern Ry. yard south of Wenatchee, Wash., has been completed and the yard was turned over to the railway by A. Guthrie & Co., contractors, on Oct. 1.

Engineer on Coal Commission

John Hays Hammond, the engineer member of the fact-finding commission appointed Oct. 10 by President Harding to investigate the coal industry, is a mining engineer of international reputation, and one who has not confined himself strictly to professional duties but has actively engaged in many enterprises outside the profession. Mr. Hammond was born in San Francisco in 1855. He is a graduate of the Sheffield Scientific School of Yale, and was a student at the Royal School of Mines at Freiburg, Germany. His honorary degrees include an A.M. from Yale, D.E. from Stevens Institute of Technology, LL.D. from St. John's College and E.M. from the Colorado School of Mines.

He began his professional career with Senator Hearst, of California, and later as mining expert with the Geological Survey made exhaustive studies of the California gold fields. He has done consulting work for many large corporations including the Union Iron Works, San Francisco, and the Central Pacific and the Southern Pacific Railroads. He became associated with Barnato Bros., London, in South Africa and later manager of the large properties of Cecil Rhodes, and consulting engineer of the Consolidated Gold Fields of South Africa.

As consulting engineer for the Tonopah Mining Co. he developed one of the richest mining properties in this country. He has also served the Guggenheim interests in the acquisition and development of large properties. Since 1907 he has been in private consulting practice.

He has served the government on previous occasions, having twice visited Russia on governmental business. He declined an appointment as minister to China offered by President Taft, but accepted his appointment as special representative of this country at the coronation of King George.

He is a member of a score or more of private, professional, scientific and technical clubs and organizations in various parts of the country.

Ninth A.A.E. Convention To Be Held in Norfolk Next May

Following the recent quarterly meeting of the board of directors of the American Association of Engineers, a decision was reached to hold the ninth annual convention of the association in Norfolk, Va., May 7-9, 1923.

F.A.E.S. Meets in Washington Next January

As provided in the constitution of the Federated American Engineering Societies, the annual meeting has to be held in Washington in January. Accordingly, the date set is Jan. 11-12, 1923.

Engineers Elected Officers of Drainage Congress

That "drainage reclamation needs no subsidy" was the keynote of the presidential address by Clark E. Jacoby, president of the National Drainage Congress, at the annual meeting held in Kansas City, Mo., in September. He stated emphactically that the association discourages and disapproves of general appropriation of government funds for the reclamation of swamp lands owned by private individuals. But the government should pay the share of the public welfare derived from reclamation, such as the benefits to health and sanitation, highway transportation, flood control and regulation of navigable channels.

The importance of engineering advice on drainage projects was voiced by R. H. McWilliams, Memphis, Tenn., who pointed out that ill-advised projects react against the development of worthy projects. Unless drainage commissioners and promoters engage the services of competent engineers and experienced contractors, financial institutions should refuse to underwrite the bonds. As a representative of bond houses, T. W. Kemper, Kansas City, spoke of the importance of one management supervising the several phases of financing, maintenance, colonization and operation.

An exhibit of excavating machinery, pumps and supplies employed in drainage work was made by about thirty firms. In connection with machinery development there was a paper by George B. Massey, Chicago, on the use of oil engines for operating dredges. Resolutions were passed endorsing a federal hydraulic laboratory under the U. S. Bureau of Standards; federal and state fish and game preserves; extension of the Flood Control Act and the jurisdiction of the Mississippi River Commission above Rock Island, and the co-operative federal and state topographic surveys. Again an engineer was elected as president, with other engineers among the officers, the list for 1922-23 being as follows: President, Jacob A. Harman, consulting engineer, Peoria, Ill.; vice presidents, Charles H. Young, Muscatine, Iowa; Roy N. Towl, Omaha, Neb.; H. J. Sternberg, St. Louis, Mo.; Willis J. Ayers, Memphis, Tenn., and directors, Clark E. Jacoby, Kansas City, and Frank B. Knight, Chicago.

Civil Service Examinations

UNITED STATES

For the United States civil service examinations listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the Civil Service Commission.

Mechanical Engineer—Vacancy in the Coast and Geodetic Survey at $3,000 per year. Application on form 1312 must be filed with the Civil Service Commission, Washington D. C., before the close of business on Nov. 7, 1922.

Laboratory Assistant, senior grade—Vacancies in the Bureau of Standards, Department of Commerce. Salaries, $1,200 to $1,380 per year, subject to increase by bonus granted by Congress of $20 per month. Examinations will be held on Nov. 8 and 9, 1922.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

FEDERATED AMERICAN ENGINEERING SOCIETIES, Washington, D. C.; Annual meeting Washington, Jan. 11-12, 1923.
AMERICAN ROADBUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Jan. 15-18.
AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual meeting, New York City, Jan. 17 and 18.
AMERICAN CONCRETE INSTITUTE, Detroit; Annual Convention, Cincinnati, Jan. 22-26.
ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual meeting Los Angeles, Jan. 30-Feb. 3.

The California Section of the American Water Works Association will hold its annual meeting in the East Bay Water Company's building, Oakland, Calif., Oct. 26, 27 and 28.

The Iowa Section of the American Water Works Association will hold its annual meeting in Iowa City and Cedar Rapids, Iowa, Nov. 1, 2, and 3. The first day's meeting will be held in Iowa City. The two following days will be spent at Cedar Rapids.

The Southwestern Geological Society elected the following officers at the close of the convention in Dallas, Sept. 16: Leon Pepperberg, Dallas, president; C. M. Bennett, Shreveport, La., first vice-president; J. W. Beede, Bartletsville, Okla., second vice-president; Dr. H. P. Bybee, Austin, Texas, secretary; R. B. Whitehead, Dallas, Tex., treasurer.

PERSONAL NOTES

CAPT. THOMAS HAROLD MESSER, Corps of Engineers, U. S. A., retired, has resumed private practice as consulting engineer with offices in the Mills Bldg., San Francisco. He will specialize in architectural and landscape development, country planning and civic betterment.

H. C. BERRY is at present serving as acting director of the department of civil engineering, University of Pennsylvania, succeeding Prof. Milo S. Ketchum, who, as already noted in these columns, has resigned to accept an appointment as dean of the college of engineering, University of Illinois.

ANTON SCHNEIDER has been appointed city manager of Lakeland, Fla. He will report for duty Nov. 15. He is at present manager for the city of Bartow, Fla. Mr. Schneider has had extensive engineering work, having served as resident engineer for the Manhattan Railway Co. in New York in charge of the construction of the Third Ave. and Bronx Park extensions, and for two years as division engineer in charge of construction on the East River tunnels, New York City. Previous to that time he was acting chief engineer with the Cerro De Pasco Railway, Peru. He also served two years with the Rapid Transit Subway Construction Co., New York City, as draftsman and assistant engineer. He is a graduate of Lehigh University.

JOHN M. RIBBLE of Petersburg, Va., has been assigned to the Ft. Worth office of the U. S. Bureau of Public Roads as junior highway engineer.

JOHN H. SAWKINS, until recently a designer in the grounds and buildings department of the General Electric Co., Schenectady, N. Y., has associated himself with the Consolidated Engineering Co., Baltimore, Md.

NORRIS H. PHILLIPS has severed his connection with the B. R. & P. Ry. Co., and has been made an assistant engineer in the New York Highway department.

W. A. JUDD has been made engineer in charge for the Layton Construction Co., general contractors of Gillespie, Ill. He was formerly assistant engineer with the Central States Engineering Co.

WILLIAM M. SHANNON has been made engineer of highways of the Morgan County Highway Department, Ala. He was formerly with the Majestic Coal & Coke Co. as engineer on new construction.

F. J. HAAGEN, until recently assistant division engineer of the Erie R.R. at Huntington, Ind.; has been elevated to the position of division engineer in charge of maintenance-of-way work in his district. He is stationed at Marion, Ohio.

WILLIAM H. SMITH, assistant engineer of the West Virginia State Highway Department, has been appointed material engineer in Dist. 10 for the U. S. Bureau of Public Roads. He is stationed in Baltimore, Md.

MELVIN E. HARTZLER has resigned from the Illinois Division of Highways and has accepted a position as superintendent for the Merom Gravel Co., Merom, Ind.

MAX L. CUNNINGHAM, state highway engineer of Oklahoma under Governor Robert Williams, has been appointed state highway engineer again by the present governor. He succeeds E. S. ALDERMAN, who resigned recently. It is understood that Mr. Alderman's resignation was due to friction between him and the governor over certain federal-aid road work. Mr. Cunningham assumed his new duties late in September.

C. R. WINKS, former city engineer of Trenton, Mo., has been appointed assistant county highway engineer of Warren County, Ind.

R. E. WILLIAMS, formerly a chemist in the Pittsburgh Testing Laboratory, has become an assistant to the city engineer of Gainesville, Fla.

C. M. OSBORN, city manager, East Cleveland, Ohio, has been appointed city manager of Kenosha, Wis. Mr. Osborn is president of the City Managers' Association.

J. B. RUTTER has been appointed chief engineer of the Merrimac Chemical Co., Boston, Mass. Other recent appointments include the following: sales manager, WILLIAM M. RAND; and designing engineer, M. S. MAXIM.

J. MINSHALL HOLDEN, former field engineer for the Turner Construction Co., has become associated with the Holden Construction Co., general contractors of Chester, Pa. Mr. Holden's new position is that of general superintendent.

WILLIAM C. EMIGH has resigned from the department of the New York state engineer to become sanitary engineer with the Midvale Steel & Ordnance Co. at Coatesville, Pa.

STANLEY F. MORSE, consulting agricultural engineer of New York and New Orleans, has been retained by the United Fruit Co. to make a complete agriculturial inspection of its Cuban sugar cane estates comprising nearly 90,000 acres.

JAMES G. COONEY, formerly assistant highway engineer of the Illinois Division of Highways, and who had charge of fifteen miles of construction work on the Meridian Trail, is now promotion engineer for the Portland Cement Association, with headquarters at Centralia, Ill.

OBITUARY

EDGAR B. TYLER, vice-president of the Mississippi Valley Structural Steel Co., St. Louis, Mo., died in St. Louis, Sept. 27, aged 57 years.

J. R. C. BROWN, at one time city engineer of Ironton, Ohio, died in that city recently, aged 87 years. He was the father of the late Prof. C. Newton Brown, professor of civil engineering at the University of Illinois.

W. E. SMYTHE, former chairman of the Irrigation Congress, an organization which succeeded, under President Roosevelt, in reclaiming large portions of arid lands in the West, died Oct. 6 in New York City, aged 61 years. Though not an engineer, Mr. Smythe had devoted a great part of his life to the irrigation movement and to colonization.

CECIL A. PRESTON, valuation engineer with the Pennsylvania R.R., died Oct. 9 at his home in Philadelphia, aged 70 years. He had retired from 40 years active service in the company's employ but two days previously. Mr. Preston was graduated from the Polytechnic College of Philadelphia in 1872. During the following five years he followed railway surveying and construction in the states of New Jersey, New York and Pennsylvania. From 1877 to 1879 he was with the Maderia and Mamore expedition that proposed to build a railroad through the Negros River valley in Brazil, a project which was abandoned in the year 1889. Following this Mr. Preston joined the engineering forces of the Pennsylvania R.R. With the exception of two years that took him to Mexico where he was employed by the National Railroads, he had been with the Pennsylvania ever since. In 1913 he was made valuation engineer, which position he had held until his death.

From the Manufacturer's Point of View

Lumber Standards Central Committee Holds First Meeting

The first meeting of the newly appointed Central Committee on Lumber Standards was held Oct. 3, in Washington, D. C., John W. Blodgett, president of the National Lumber Manufacturers Association and chairman of the committee, presiding. The committee reviewed the standardization progress to date, including the proceedings of former general conferences.

A specific program for future work was outlined to cover (1) grade simplification, (2) size standardization and (3) certification of quality and quantity for the protection of the public.

A representative committee of lumber producers is being formed from appointees of the various manufacturers' associations to co-operate with the Secretary of Commerce and with the Central Committee on Lumber Standards. Similar committees or representatives are also being appointed from the lumber retailers, wholesalers and consuming interests.

Discussion Concluded on Fewer Grades of Asphalt

With the following comment by Major Besson, Mr. Adler and Col. Compton discussion is concluded on the subject of reducing varieties of asphalt called for in specifications for road and paving work, as proposed in the Sept. 28 issue of *Engineering News-Record*. Judged from the opinions expressed the proposal has been favorably received by highway engineers whose views, together with those of the producers of asphalt, are now available for such use as society committees and other specification-making organizations may make of them.

F. S. BESSON
Major Corps of Engineers, U. S. A., Assistant to the Engineer Commissioner, Washington, D. C.

In designing asphalt pavements there must be realized the purpose for which certain restrictions are placed on bituminous materials and the purpose served by each of the ingredients entering into the complete pavement mixture. Primarily, though there may be secondary classifications, asphalt specifications cover two classes of requirements:

FIRST CLASS

Penetration	Bitumen Percentage
Ductility	Specific Gravity.

Required for purposes of identification, factory control, and gauging the uniformity of supply.

SECOND CLASS

Flash Point	Penetration of Residue
Loss on Heating	

Required for estimating the heat that may be used in mixing and the effect of aging after the mixture is placed in the pavement.

Bituminous mixtures are composed of three elements: Bituminous cement; aggregate (sand, for instance); and filler (usually limestone dust). These three elements may be combined in such proportions that, at the will of the engineer, a roadway surface may

(*Continued on p. 676*)

The following article presents the manufacturer's side of the problem. In next week's issue will begin a discussion of winter buying from the point of view of the purchaser of pipe. The following water-works engineers and officials will express their opinions:

F. A. Barbour, Boston.
G. H. Fenkell, Detroit.
F. C. Cutts, St. Louis.
W. S. Cramer, Louisville.
J. A. Jensen, Minneapolis.
C. E. Davis, Philadelphia.
F. C. Jordan, Indianapolis.
W. C. Hawley, Wilkinsburg.
C. R. Henderson, Davenport.
D. R. Gwinn, Terre Haute.
C. M. Saville, Hartford.
G. W. Batchelder, Worcester.

Cast-Iron Pipe Makers Decry Seasonal Buying

Benefits Would Follow Distribution of Purchases Throughout the Entire Year

SO COMMON is the practice of buying cast-iron pipe a few weeks previous to the time it is to be laid that both buyers and manufacturers have had to pay an unnecessary penalty for the delay in purchase. Consideration of the effect of this summer buying of pipe on the final cost of the pipe in the ground would result in spreading the purchase of this material over the entire year, to the advantage of all concerned. This is the opinion expressed to *Engineering News-Record* by a spokesman for the cast-iron pipe industry, whose views on the general subject are summarized below.

It is easily comprehended how the product of a costly plant working at its maximum capacity for about six months in the year must necessarily cost more than if a constant rate of manufacture could be maintained. Whether the plant is running on full or part time it is impossible to avoid charges for interest on the investment, depreciation on buildings and equipment, insurance, and taxes. In general, all property expense continues whether pipe is being manufactured or not and the expense must necessarily be reflected in the price of the finished product.

EFFECT ON LABOR

Concerning labor, the same condition is true to a considerable extent. Office and supervisory help cannot be expanded and contracted during the year to correspond with output. The many skilled laborers in shops where specialized knowledge is necessary—in the pipe shops, for example—must be provided for. Even the common labor turn-over that results in the wide variation in demand for pipe is a source of considerable expense. If a constant rate of output could be maintained, the office supervisory and labor forces could all work at a uniform rate and at a maximum of efficiency and result in the elimination of considerable unnecessary expense.

Another consideration of no small importance is the effect of climate on the efficiency of the individual workman.

Most of the pipe foundries are in the South, where the heat is so extreme that workmen, especially in the foundries, are affected. Hence the desirability of winter work, with its lower quota of "lost" pipe.

When all pipe buyers come into the market for pipe at the same time and demand immediate delivery, what is the result? Instead of keen competition between makers of pipe, the competition is reversed and the buyers compete with one another for deliveries. This condition could easily affect the price of pipe in a way that would not be to the benefit of the buyer.

Pipe Laying in Winter

In many parts of the country pipe is not laid during cold weather. With modern trenching methods, however, a small amount of frost in the ground has little effect on the cost of excavation, and work can be carried on just as well in cold as in hot weather. Even where conditions are such that pipe cannot be laid, delivery of pipe on a job is often easier with the ground frozen than it would be later in the year.

The reduction in cost of hauling made possible by winter buying is of no small importance in many cases and in low swampy land amounts to a great part of the laying cost. As there is no danger of deterioration of cast-iron pipe due to exposure while strung along the proposed pipe line, there is no reason why the pipe cannot be delivered many weeks or even months in advance of laying.

The purchase of pipe in the winter and its delivery on the job makes it possible to make a definite plan for water extensions and to carry out this plan on a definite schedule. Concentrated buying must naturally result in delayed delivery and, as a consequence, the disruption of extension plans, the laying off of pipe-laying gangs, delay in laying pavements, dissatisfaction of property owners and a higher cost to all concerned.

The cessation of pipe-laying during the war has made the concentrated buying even more severe at the present time than in normal years. The delayed improvements must go in, and in many cases, can be put off no longer. This condition will probably exist for several years and it is to the interest of the pipe buyer as well as the pipe seller, to spread the purchase of pipe over the entire year rather than confine pipe manufacture and pipe laying to a few months in the year as is the present general practice.

Tars and Centrifugal Pipe To Be Discussed

At the luncheon meeting of the New England Water Works Association at the Boston City Club on Nov. 14, there will be shown motion pictures of the pipe being cast by the centrifugal process at the Birmingham plant of the U. S. Cast Iron Pipe & Foundry Co. A paper on "Iron Castings" will be presented by Dr. Richard Moldenke, consulting chemist. "Tars" will be the subject of an address by S. R. Church, of the Barrett Co.

Asphalt Discussion Concluded

(*Continued from p. 675*)

be obtained that will be friable—and it will crack; that will be too soft—and it will creep into waves; or, that will be neither friable nor too soft and will, therefore, give good service. This can be done using any one of a number of well known bituminous cements. The fact that there is a choice of penetrations, ranging from soft cements to hard, is but an incidental aid to the engineer in designing mixtures. Ductility, bitumen percentage and specific gravity may vary greatly and, whether the cement is a straight residual, a blown petroleum or a lake asphalt, these factors might well be whatever the manufacturer of the particular product has found to be most satisfactory.

Having designed an asphalt paving mixture, based upon a certain brand of cement of a given degree of hardness, tests relative to the characteristics of the first class, noted above, are useful mostly for gaging the uniformity of supply. As for the penetration test, certainly a 10-point latitude should be allowed for cements below 90 penetration. The personal equations of many investigators cover almost as wide a range as that.

The characteristics of the second class—flash point, loss on heating, and penetration of residue—are of importance to the engineer in the field rather than to the laboratory man. May sufficient heat be applied at the plant to turn out a mix satisfactory to the gang on the street, and will the cement after 10 or 20 years of service in the roadway be as "live" as when first mixed? These are questions of primary importance and the second one, it is feared, can never be fully answered by means of any accelerated laboratory test. The A.S.T.M. tentative specifications require:

Flash Point: Not less than 175 deg. C. (347 deg. F.)
Loss on heating at 160 deg. C. (325 deg. F.) 50 g., 5 hours: Not more than 2 per cent.
Penetration at 25 deg. C. (77 deg. F.) 100 g., 5 sec., of residue: Not less than 60 per cent of the 25 deg. C (77 deg. F.) Penetration.

It is believed these requirements need not be more rigid, except possibly for the flash point. There are many aggregates that cannot be satisfactorily handled unless they reach the job at approximately 400 deg. F. Apparently, however, raising the flash point would place no undue hardship on the manufacturers for most cements on the market flash well above 400 deg. F.

Col. R. Keith Compton

Chairman and Consulting Engineer, Paving Commission, Baltimore

This office is in full accord with the efforts displayed by your magazine in the article on asphalt "From the Manufacturers Point of View," in the issue of Sept. 28, 1922. The matter of standardizing specifications for materials for public work will certainly have a tendency towards economy, not only on the producers' side but also on the construction side.

The number of brands of asphalt cement should be reduced between certain limits, but these limits should be decided upon after a full, open and candid discussion before a committee composed of manufacturers, contractors and engineers, federal, state and municipal. The engineers can be largely represented through our several technical organizations, such as the American Association of State Highway Officials, the American Society for Municipal Improvements and the American Society for Testing Materials.

In order that the work of such a committee could fit in with the specifications adopted by the two latter societies it is suggested that the chairmen of committees handling such work for these societies be members of the proposed standardizing committee. Reference need only be made to the excellent work done last year and this year by the committee appointed for standardizing vitrified paving brick. This committee held its first meeting in Washington last fall and found that there were some 66 varieties and styles of paving brick being made. At the first meeting, lasting all day, these were reduced to 11, and at a subsequent meeting held last spring they were further reduced to 7.

Such action is necessary in all industries if we are to look for economy and uniformity in practice. Your magazine could not perform a better service to the construction industry at this time than to advocate such procedure in all lines where it is possible to do so.

Julius Adler

Deputy Chief, Bureau of Highways, Philadelphia

The statement of the manufacturers' viewpoint on the production of asphalt products for highway purposes clearly shows an unwarranted lack of standardization of penetration requirements. The responsibility for this situation is placed so squarely upon the shoulders of the engineers and consumers that it is only fair to consider the other side of the matter. There is but little indication that the producers themselves, until perhaps very recently, have evidenced any very concerted desire to standardize the various products; the effort rather seemed for each producer to try to standardize his own products with the hope that the consumers would fall in line with their practice.

In the next place, the over-enthusiasm which is noted as existing among some of the consumers in the introduction of special requirements and test limits in their specification (apparently believing that great things could be accomplished from some of these highly technical variations) is a condition which the producers fostered themselves in the early stages of the use of bituminous materials in highway work. Now that this erroneous idea is widespread, it is no simple matter to check it completely.

In the matter of permissible range of penetration, there are few, if any, cases where a variation within 10 points is not sufficiently close for the purposes of the consumer. There is no doubt that the method of expressing penetrations, and the fact that a skillful operator can readily detect, say, 5 points difference in penetration between two samples, has resulted in a false idea of the significance of a few points variation as applied to the pav-

ing mixtures. On the other hand, with permissible 10-point ranges for successive grades, the producer must recognize his responsibility in establishing a clearly determinable difference between his products.

For example, if one grade is designated as 40 to 50 and another grade as 50 to 60, they must be prepared in general with the intention of being midway between these limits, and not on the dividing line between the two grades, since the latter practice defeats the attempt of the consumers at proper selection. It was undoubtedly this idea which led to the form of specification referred to as providing a 9 point range, for example, 40 to 49 and 50 to 59 (actually a 10 point range, not 9) which in a measure prevents the producer from supplying two grades from a single product.

In all fairness, however, it should be conceded that the situation of the producers is one that deserves immediate consideration from the consumers and specification-making organizations. Though the adoption of uniform standards in highway matters is always comparatively slow and there is always a small proportion of specification writers who may insist upon including individual peculiarities in their specifications, the writer believes there is no serious obstacle in the way of a general standardization of the heavier grades of asphalt for highway work.

Business Notes

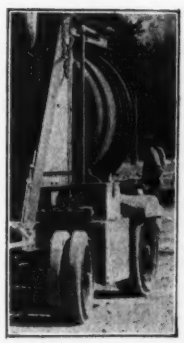
THE NORTHWEST ENGINEERING CO., Green Bay, Wis., manufacturers of crawlers, cranes, draglines, shovels and other equipment, announces the appointment of C. R. Dodge as sales manager, effective Oct. 15. From 1910 to 1917 Mr. Dodge was in charge of the Milwaukee Concrete Mixer Co.'s business in the East, and also operated his own organization handling a general line of contractors' equipment in New York under the name of C. R. Dodge & Co. Early in 1917, when the Lakewood Engineering Co. took over the sale of the Milwaukee concrete mixers, Mr. Dodge opened the first Lakewood district office in Philadelphia where he remained until 1918, when he became field sales manager for the Lakewood organization in charge of all district offices and agencies. Since 1920 he has been western sales manager for Lakewood. W. W. Mutter, vice-president of the Northwest company, who has formerly handled sales organization, will devote his attention to production and special problems.

THE INTERNATIONAL COMBUSTION ENGINEERING CORP. announces through its president, George E. Learnard, the acquisition of the entire capital stock of the Green Engineering Co., East Chicago, manufacturer of chain gate stokers, auxiliary boiler-room equipment, special furnace arches, and general foundry work.

Equipment and Materials

Demand Grows for Rubber Tires on Concrete Mixers

A growing demand for rubber-tired wheels, instead of the usual standard steel wheels, on concrete mixers of the smaller type, especially the one-bag size, has been noted by the Chain Belt Co., Milwaukee. This is especially true on city work where the mixers must frequently be hauled for considerable distances over hard surfaced roads, often brick or stone, across street-car tracks and other obstructions.



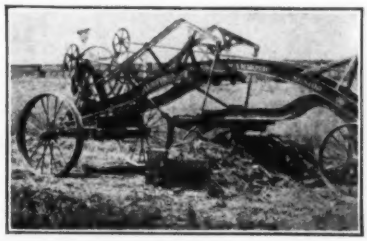
The mixer, at right, in the illustration is one of seven Rex concrete mixers operated by the City of Milwaukee, while the Rex paver shown is operated by the Milwaukee Electric Railway & Light Company. Both are equipping a great deal of their construction machinery with rubber tires and find that it reduces the wear and tear considerably.

Double-Ender Attachment Extends Road Grader Blade

An attachment called the "double-ender" has been developed by the Austin-Western Road Machinery Co., Chicago, by means of which a road grader blade may be extended 3 ft. on each end, or, with the attachment set at right angles to the blade, converted into a wheeled scraper, as shown in the accompanying illustration. While blade extensions are not new, previous types have been rigidly bolted onto the end of the blade necessitating for their removal a number of tools and much time. Such extensions, when detached, are frequently mislaid or lost.

The feature of the double-ender attachment is its hinged construction. It may be permanently attached to any size of Austin grader and when not needed may be swung back out of the way, by withdrawing a bolt in the quadrant hinge which holds the extension out. In this position, however, it is still attached to the blade. A pair of these attachments adds 6 ft. to the width of a grader blade, 3 ft. on each end. If desired, only one end may be extended.

To convert the grader into a wheeled scraper the double-ender attachments are swung through an angle of 90 deg. and held perpendicular to the plane of the main blade by dropping an adjusting bolt in the proper hole of the quadrant hinge. The wheeled scraper thus formed holds from 1 to 2 cu.yd. of earth and is useful for cutting off ridges in the road and carrying the earth forward into hollows. For all graders the 3-ft. extension attachment is uniform. They are furnished as extra equipment on new machines or may be attached to old graders by drilling a few holes in the blade.



All-Steel Logging Wheel Hauled by Crawler Tractor

An all-steel logging wheel designed for use with the crawler type of tractor has been in use for three months on the Pacific Coast. It is manufactured by the Reliance Trailer & Truck Co., of San Francisco. The height in the clear between the wheels is 6 ft. and the width between wheels 6 ft. 6 in. The outstanding feature of the design are the steel wheels 5 ft. 6 in. high, with tires 10 in. wide, and Timken bearings in the hubs. Another feature is the rack-and-gear slip-tongue arrangement for raising and lowering the load. The gear ratio is such that the load is readily lifted clear of the ground as soon as the tractor pulls on the tongue and quickly dropped on down grades when the wheels tend to crowd up against the tractor.

Publications from the Construction Industry

Roof Insulation—UNION FIBRE CO., Winona, Minn., in a 10-p. illustrated bulletin, presents data to aid in the determination of the kind of insulation and thickness required to prevent condensation on the inner side of a roof. The information also may be used to calculate the saving in fuel and radiation effected by roof insulation. A psychrometric chart indicates the allowable difference in temperature between the air in a building and the inner surface of a roof before condensation will occur. There is also a table showing the conductivity and resistance of roofs, uninsulated and insulated with the Union company's product. The method of using the data is clarified by the working out of an actual problem.

Business Side of Construction

Facts and Events that Affect Cost and Volume

Credit Men's Executive Doubtful as to Business Boom

In a survey of business conditions relating especially to the question of commercial credit J. H. Tregoe, executive manager of the National Association of Credit Men, points out for the benefit of the members of his association that all in the business world is not rosy and that even since the upturn of a month ago difficulties have arisen.

Mr. Tregoe declares that there is nothing in the situation either at home or abroad that would suggest an imminent boom. The wheat crop, he contends, has been disappointing both as to yield and price, due possibly to competition with a fine Canadian crop which, together with reduced purchasing power abroad, has affected the price of our own yield. The cotton crop, he believes, will undoubtedly be short of original expectations and, although the carry-over may be dangerously reduced, he fears that unfavorable export conditions will militate against a good price for this staple.

Mr. Tregoe does not derive much confidence from the settlement of the coal strike. He sees only an enormous economic sacrifice without any compensation and quotes with approval the opinion that due to high prices and high costs the situation in the industry is unsound. All this is despite the fact that an active fall business is forecast. If we are to get the full and lasting benefit from this, however, present problems must be handled with skill and prudence. Mr. Tregoe believes that a large share of the outcome now rests in the hands of the banks who are in position to encourage sound enterprise and to discourage speculation.

Favorable Factors

Mr. Tregoe summarizes the favorable factors in the present situation as follows:

1. Increased volume of business. This increase is reflected by carloadings, bank clearings and other indices of business volume. 2. Adjustment of the coal strike and the collapse of the shopmen's strike. We put these in the favorable column merely because of their immediate effect, and not because they betoken a permanent settlement of the questions involved. They might just as well be placed in the unfavorable column of this summary. 3. Large increases in the production of basic commodities, apparent in iron, steel and other commodities of basic importance. 4. Increased production in some of our larger industries. This is discernible in quite a few industries. 5. Increase in orders for railroad equipment. 6. The President's veto of the bonus bill. This action removes what might have been a serious burden to our recovery. 7. Improved condition of credit. This improvement is very noticeable in the reserves of banks and the credit available for sound enterprises and aside from speculative purposes.

The unfavorable factors, in Mr. Tregoe's view, are: 1. Disparities still existing in the relation of prices to one another, particularly the disparity existing between prices of farm products and manufactured products. 2. Low prices of farm products. This situation is limiting the buying power of the farmer, although this condition is very much improved over a year ago. 3. Advance in prices of production costs. Undoubtedly, and as we have pointed out many times, advances in fabricated commodiities, and particularly where they are based on higher production costs, will unfavorably affect our recuperation. The price must be steadfastly watched. 4. High prices of fuel and lighting. In August fuel and lighting stood at 271 as against 155 for the general index. This is serious as affecting home and industrial necessities. 5. Continuing unsettled situation in European and in Near East affairs. Recent complications in the Near East are serious and must have their effect on world production.

Bureau Public Roads Get Big Freight-Rate Reduction

The Western States will save considerable money in payment of freight on surplus war material through new rates which have been secured by the Bureau of Public Roads. Large quantities of material are still being received by the Bureau and alloted to states for use in road construction. Recently through representation of the Bureau as to the character of the material and the use to which it is to be put considerably lower rates were granted. On transcontinental shipments, motor vehicles now take a rate of 95 cents per hundred against a former all rail rate of $5.35. Machinery takes a rate of 60 cents per hundred and similar reductions have been made on other classes of material. These rates have been effective only a short time but have been immediately reflected in requisitions from the West.

British Will Build Roads to Relieve Unemployment

The British Ministry of Transport has under consideration various schemes to improve highway services and at the same time to alleviate unemployment to the extent of £7,000,000. The ministry is authorizing first those schemes which will meet urgent public needs in the matter of road transport. Most of this work is in the nature of driving straight roads between the large cities, for instance the Manchester-Liverpool road, which is estimated to cost £3,000,000. Work on this road will largely be carried out by unskilled labor and would solve one of the most difficult traffic problems in the country. On the certificate of the Minister of Labor that serious unemployment not otherwise provided for exists in the areas concerned in the schemes, the Minister of Transport has already approved projects estimated to cost £1,500,000.

Immigration Restriction Affects Labor Supply

Construction Industry Among First to Feel Effect of Cutting Down Supply of Common Labor

Reports from many cities indicate a well-defined shortage of common labor, particularly in the construction field. Whereas a year ago seventeen of the twenty-one cities in which construction conditions are reported by *Engineering News-Record* showed an actual excess of labor, with men out of work in large numbers, a condition wholly reversed prevails today. Labor shortage and general wage increases are the rule, not only in the construction field but also for industry in general. The Department of Labor reports an increase of employment in sixty-five cities and a decrease in only seventeen.

Immigration Reports

Some measure of this increased employment and the accompanying increased wages is due to a revival of business, but the impression prevails that a very important factor is the effect of the restriction of immigration upon the supply of common labor. The reports of the Department of Labor show that for the twelve months ending last June the net immigration—that is, the excess of immigration over emigration—was only 110,844. When we inspect the records kept on the basis of occupation we find that those immigrants classed as laborers numbered 32,726, while the laborers who emigrated were 100,058. This shows a net loss of 67,332 in this class of essential labor. It should be noted also that of the net increase here given, 104,326 were females, while only 6,518 were males. Unquestionably some part of the males were children. Taken as a whole, the figures for immigration based on occupation, either professional, skilled, or miscellaneous, show a net decrease of 6,534, while those for immigrants of "no occupation (including women and children)" show a net increase of 76,106. These figures are to be contrasted with an average net gain of between 700,000 and 800,000 annually in the years preceding the war.

It may be worth-while to recall at this point that legislation now in force limits the number of persons who may come into this country from the various foreign countries to 3 per cent of the total number of aliens of those countries who were living in the United States in 1910. This contemplates the annual entry of 360,000 people, but as a matter of fact the actual immigration falls considerably below this figure, as the law does not permit a deficiency in one nationality to be made up by an excess of another. The result is that instead of admitting 45 per cent of the normal increase due to immigration of other years we admit only 11 per cent, of which only a small part may be counted upon to improve our supply of common labor.

It is estimated that the population

of the country increases at the rate of about 1,400,000 annually, or about fourteen per 1,000, so that we require an addition of fourteen manual laborers annually per 1,000 of those already in the trade. Applying this ratio to the manufacturing and mechanical industries we must find annually 154,000 additional laborers to add to the 214,000 who are required to replace losses caused by death and retirement. This makes an annual need for 368,000 new workers annually in these fields.

The situation is aggravated, of course, by the fact that a relatively small number of those born in this country, even those of foreign parentage, may be relied upon to augment our supply of common labor. Although in Europe the tendency is for sons to follow their fathers' occupation, this is not true with us; and in order to supply the deficiency in common labor caused by this condition we are peculiarly dependent upon immigration. But as the ranks of skilled labor are recruited from those of the unskilled, it is a question of time only when the dearth will be felt there also.

Although few would go so far as to advocate a return to the free and unrestricted immigration of other days, a widespread opinion prevails that the present legislation is likely to work more for evil than for good. It is felt that rather than an arbitrary limitation of numbers upon the immigration from various foreign countries, we need a more scientific and discriminating selection of workers on the basis of the country's industrial needs. Owing to the business depression that has prevailed for the last year or two, this whole question has been in the background, but with the present revival and with the promise of a further awakening, attention has been focused sharply upon it. If the slight increase of recent months can make itself felt to the extent already reported, it is believed by those well informed that the prospects justify most serious consideration on the part of the most constructive thought that can be brought to bear upon the problem.

Heaviest September Bond Issues in Last Thirty Years

Sales of long-term municipal bonds during September, totaled $94,590,507 as against $66,360,551 for August and $88,656,257 in September, 1921. This represents the highest total value for the month of September, realized in any similar period during the last thirty years. The total for the nine months, $905,770,787, represents the highest total for that period, since 1892. Short-term securities totaled $47,831,000, of which $42,410,000 was issued by New York City alone.

Records kept by the *Commercial and Financial Chronicle* further show that the number of municipalities issuing permanent bonds and the number of separate issues made during September were 442 and 615, respectively as against 516 and 663 for August and 377 and 478 for September, 1921.

Among the more important issues were: Chicago, $8,095,000 4s at 98.639, a basis of about 4.16 per cent; Illinois, $6,000,000 4s at 99.686, a basis of about 4.03 per cent; Detroit, $5,009,000 4½s; Missouri, $5,000,000 4½s at par, plus a premium of $32,215, equal to 100.644, a basis of about 4.35 per cent; Milwaukee County, Wis., $4,300,000 5s at 107.36, a basis of about 4.20 per cent; Buffalo, $3,580,000 4½s at 103.109, a basis of about 3.90 per cent; Michigan, $2,000,000 4s and $1,000,000 4½s at 100.012, a basis of approximately 4.08 per cent.

Of the forty-three representative issues shown in the accompanying table, six sold at par, thirty-five above, and only two below par; the yields ranging from 3.93 to 5.89 per cent. The rates varied from 4 to 6 per cent. All those drawing 5½ and 6 per cent were in the Southern and Western states; the 4½s, 4¼s and 5s were mostly in the Middle Atlantic states with several in the West, while the 4s were confined to Massachusetts, Illinois and Michigan.

RECENT REPRESENTATIVE PUBLIC BOND SALES

State	Purpose	Amount	Maturity	Rate Per Cent	Basis	Sold For	Dated	Purchased By
Illinois	Highway	$6,000,000	.....	4	4.03	99.686	Sept., 1922	Dillon, Read & Co.; Wm. R. Compton and Hakey, Stuart & Co., all of Chicago.
Missouri	Road	5,000,000	.....	4½	4.35	100.644	Sept., 1922	Watkins & Co., Hornblower & Weeks and others of New York.
Michigan	Highway imp't.	2,000,000	.....	4	4.08	100.012	Sept., 1922	Eastman, Dillon & Co. and others
		1,000,000	.....	4½	4.08	100.012		
County								
Allen, Ind.	Road	16,000	1923–32	5	4.76	101.14	Sept. 15, 1922	Fletcher Savings & Trust Co., Indianapolis; Thos. D Sheerin, Indianapolis
		15,000			4.74	101.21		
Auglaize, Ohio	Road	8,200	1927	5½	4.93	102.73	Oct. 3, 1922	W. L. Slayton & Co.
		10,500	.....	5½	....	102.73		
Benton, Ind.	Highway imp't.	16,000	1923–32	5	....	101.30	July 15, 1922	J. F. Wild & Co., State Bank of Indianapolis
Clay, Ind.	Highway imp't.	10,100	1923–32	5	4.75	101.16	May 22, 1922	Thos. D. Sheerin & Co. of Indianapolis
Cuyahoga, Ohio	Road	95,925	1924–32	5	4.75	101.67	Oct. 1, 1922	Hayden, Miller & Co. of Cleveland
		91,634	1923–31	5	4.64	101.67	Sept. 1, 1922	
Dubois, Ind.	Highway	14,500	1923–32	4½	....	100.	Aug. 15, 1922	To contractors
Hudson, N. J.	Road	380,000	1923	4½	....	100	.....	Sinking Fund Commission
Lafayette, Mo	Road and bridge	258,000	1923–42	5	....	105.01	Nov. 1, 1922	W. R. Compton Co. of St. Louis
Mahoning, Ohio	Road imp't.	67,000	1924–32	5½	....	103.38	Sept. 1, 1922	W. L. Slayton & Co. of Toledo
New Castle, Del.	Highway	140,000	1933–37	4½	4.38	101.0656	July 1, 1920	Graham, Parsons & Co., Wm. R. Compton Co.
North Saint Lucie River Drainage Dist., Saint Lucie Co., Fla.	Ditch	500,000	1927–47	6	....	95	May 1, 1922	J. L. Arlitt of Austin
Pulaski, Ind.	Highway imp't.	10,000	1923–32	5	4.74	101.20	Aug. 1, 1922	W. Sabel
Trumbull, Ohio	Road	55,000	1924–32	5½	....	103.88	Oct. 22, 1922	W. L. Slayton & Co.
Weldon River Drainage Dist., Decatur Co., Ia.	Ditch	28,000	1926–35	5½	....	101.30	Sept. 5, 1922	Geo. M. Bechtel & Co. of Davenport
Municipality								
Ada, Minn.	Electric lights	25,000	.....	5	....	101.26	.....	Hanchett Bond Co., Chicago
Aguadilla, Porto Rico	Improvements	85,000	1927–51	5	....	102.47	July 1, 1922	John Nuveen & Co., Chicago
Ashland, Ky.	Water	90,000	1957–61	4½	4.55	103.31	Jan. 1, 1922	Richards, Parish & Lamson of Cincinnati
Beacon, N. Y.	Water	39,000	1923–38	4½	4.24	100.04	Oct. 1, 1922	Sherwood & Merrifield of New York
Bucyrus, Ohio	Street imp't.	17,400	1923–31	5½	....	102.21	Sept. 1, 1922	Richards, Parrish & Lamson of Cleveland
Cortlandt, N. Y.	Water	6,500	1924–36	5	4.82	101.03	Sept. 29, 1922	Geo. B. Gibbons & Co. of New York
East Grand Rapids, Mich.	Water extension	25,000	1937	4½	4.53	102.33	Oct. 15, 1922	Detroit Trust Co.
	Sewage treatment	12,000	.....	....	....	.....	.....	.....
Eaton, Ohio	Street imp't.	12,000	1924–29	5½	5.17	101.14	Sept. 15, 1922	Preble County Nat. Bank
Fostoria, Ohio	Street imp't.	38,000	1924–32	5½	4.82	103.51	Sept. 1, 1922	Detroit Trust Co., Detroit
		8,400	1924–32	..	....	.....	.....	.....
		2,400	1924–31	..	....	.....	.....	.....
Fulton, Ohio	Highway	14,502	1924–28	5½	5.10	101.45	Nov. 1, 1922	Durfee, Niles & Co. of Toledo
Grand Rapids, Mich.	Road	23,220	1924–32	5	....	100	June 1, 1922	.....
Hamler, Ohio	Street imp't.	9,361	1923	6	5.89	100.85	Sept. 15, 1922	Prudden & Co. of Toledo
	Sewer	1,900						
Honolulu, Hawaii	Public imp't.	500,000	1932	5	....	102.082	July 1, 1922	Geo. B. Gibbons & Co., N. Y. C.
Hempstead, N. Y.	Water extension	15,000	1925–32	4½	....	100	Nov. 1, 1922	First National Bank of Hempstead
Leland, Miss.	School and light	14,000	1923–36	5½	....	100.89	Oct. 1, 1922	Bank of Leland
Loveland, Wyo.	Water	50,000	1937–57	4½	....	100.30	.....	James A. Cansey & Co. of Denver
Madell, Okla.	Waterworks	41,000	1940–50	6	....	104.19	Jan. 15, 1922	The Brown-Crummer Co. of Wichita
Mayville, N. D.	Septic tank	7,500	1937	6	....	108.20	Oct. 1, 1922	Merchants' Trust & Savings Bank of St. Paul
Nichols, N. Y.	Bridge	10,000	1924–33	5	4.69	101.623	Sept. 15, 1922	O'Brian, Potter & Co. of Buffalo
Red Bank, N. J.	Gen'l. imp't.	167,000	1923–51	4½	4.30	102.155	Sept. 1, 1922	Red Bank Trust Co.
Saugerties, N. Y.	Water	40,000	.....	4½	....	101	Sept. 30, 1922	Saugerties Savings Bank
Somerville, Mass.	School	250,000	1923–42	4	3.93	100.569	Oct. 2, 1922	Stacy & Braun and Parkinson & Burr of Boston
Trinidad, Col.	Water	365,000	1937–57	4½	....	100	Oct. 1, 1922	E. H. Rollins & Sons of Denver
Wilmington, Ohio	Street imp't.	6,000	1923–32	5½	....	103.006	July 1, 1922	Clinton County Nat. Bank
Winterville, N. C.	Light and imp't.	10,000	1945	6	....	100	Sept. 1, 1922	George & Fetner of Cherryville
Yanco, Porto Rico	Imp't.	130,000	1924–40	6	....	106.50	July 1, 1922	John Nuveen & Co. of Chicago

Engineering Employment Reflects Upward Turn of Business

Engineering business is better. At least that is the indication from the August report of the employment service of the American Association of Engineers just issued. Sixty-eight fewer applications were received than the 1,484 in July; but 467 positions were available in August as against 413 in July. Only 1,140 men were referred, less in number by 290 than in the previous month. Of the men placed 219 were put to work, against 206 in July. Compared with these figures are the August 1921 statistics noting 2,320 applicants, 360 positions, 2,250 men referred and 204 men placed. The average salary of positions in August was $188 per month.

Living Cost Changes Slowly

Changes of cost of living in thirty-two cities, and in the United States as a whole, from June to September, 1922, were very slight, ranging from 1.6 per cent decrease to 1.4 per cent increase, according to the United States Bureau of Labor Statistics. In many cases the change was under a half per cent.

Road Bond Issues in Texas

Harris County (Texas) will vote on a $6,000,000 good-roads bond issue and a $3,000,000 issue for the improvement of the Houston Ship Channel at the next general election to take place Nov. 7. Other issues being considered include the following: Anderson County, actively at work for a proposed $1,500,000 good-roads issue to be voted upon in the near future; Collin County one district alone, working for a $450,000 issue for good roads; Orange County, where a $700,000 issue of special road bonds has been approved.

Weekly Construction Market

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of October 5; the next, on November 2.

Steel Products:	New York	Atlanta	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Structural shapes, 100 lb.	$3.14	$3.95	—$2.90	$3.15	$3.80	$3.25	$3.75	$3.75
Structural rivets, 100 lb.	3.85	4.60	3.35	+4.00	4.80	4.50	5.00	6.50
Reinforcing bars, ¾ in. up, 100 lb.	3.04	3.85	—2.80	3.05	3.97½	3.00	3.75	3.25
Steel pipe, black, 2½ to 6 in. lap, discount	57%	61.15%	59½%	58.9-5%	43%	47.9%	45%	30.00
Cast-iron pipe, 6 in. and over, ton.	55.30	51.00	48.70	55.50	+63.00	51.00	54.00	55.00
Concreting Material:								
Cement without bags, bbl	2.60	2.54	2.20	2.39	2.85	2.71	2.90	2.88
Gravel, ¾ in., cu.yd	1.75	2.00	2.00	1.75	1.75	2.25	1.00	1.50
Sand, cu.yd	1.00	1.35	2.00	1.00	0.75	1.50	1.00	1.25
Crushed stone, ¾ in., cu.yd	1.75	1.90	1.60	2.25	3.50	2.25	3.00	1.90
Miscellaneous:								
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	59.00	42.00	51.00	41.00	39.75	35.00	24.50	50.00
Lime, finishing, hydrated, ton	15.80@16.17	23.00	18.00	—25.50	24.00	22.00	24.00	21.00
Lime common, lump, per bbl.	2.75@3.14½	1.85	1.40	1.40	2.70	1.75	2.80	11.00
Common brick, delivered, 1,000	18.00@19.10	12.00	11.00	18@19	12.00	15.00	14.00	16.00
Hollow building tile, 4x12x12, per block	Not used	.0776	.1101	.09	.065	....	.11	.08@.16
Hollow partition tile 4x12x12, per block	.1230	.0776	.0808	....	.065	.108	.11	....
Linseed oil, raw, 5 bbl. lots, gal.	.93	.97	.97	.98	1.08	1.04	.86	1.06
Common Labor:								
Common labor, union, hour	.60	.35	.....	.....	.50@.55	.56¼	.50@.60	.....
Common labor, non-union, hour	.44@.60	.30	.72½	.35@.50	.35@.50	.47½@.50	....	.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given: 45-5% means a discount of 45 and 5 per cent. Charge is 15c. per 100 lb. for cutting reinforced steel into 2-ft. lengths or over.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Cement and concrete laborers' rate, 81¼c.; pick and shovel men, 60c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.55 for Sheboygan. Common labor not organized.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered, in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

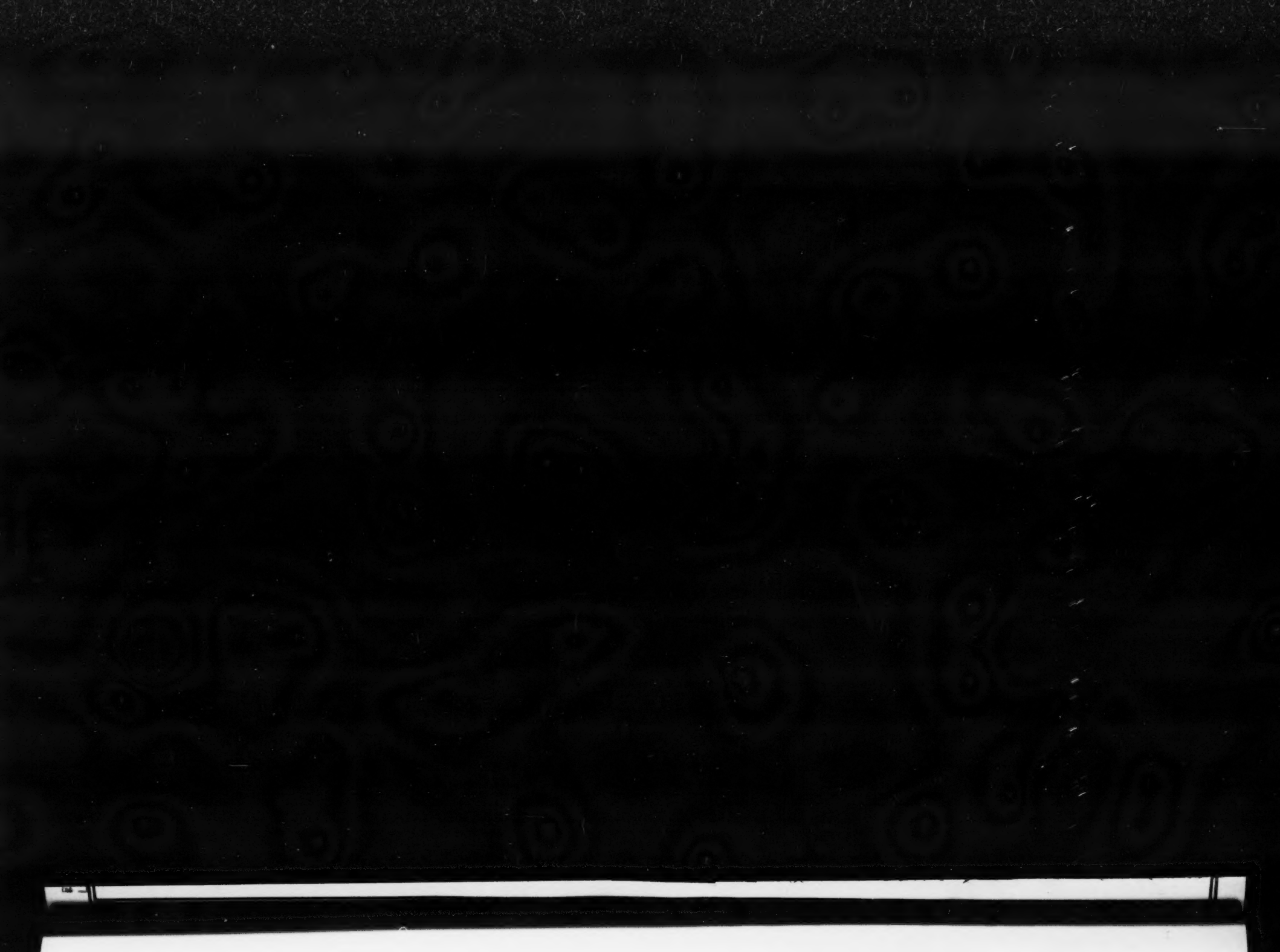
San Francisco quotes on Heath tile, 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on Douglas fir instead of pine. Sand, stone, gravel and lump lime per ton. Cement, lime and tile are delivered; sand, gravel and stone on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at par.) Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½-in., $30; 6-in., $110.

Changes Since Last Week

Cast-iron pipe up $3 in Denver and $2 in Atlanta, with market in the East unusually active. Transportation in the South is so unsatisfactory as to be discouraging to the placing of new business, as well as to prevent delivery of pipe long on order.

Plain shapes down 12½c. per 100 lb. in Chicago warehouses. Mill shipments are $2.10@$2.34, Chicago. Bars are also down 12½c., warehouse. At Pittsburgh the accepted market on large tonnages is $2, with not many important jobs appearing. Rivets advanced in both Minneapolis and Atlanta, 22½c. and 15c. per 100 lb., respectively. Structural and heavy ship rivets in Pittsburgh, $3.15. Despite poor movement of finished steel from the mills, four more blast furnaces have opened in the Central West.

Production of lumber is being restricted by the scarcity of cars and many mills are unable to operate due to lack of storage space until shipments are increased, according to the weekly analysis of the statistical bureau of the American Wholesale Lumber Association. For the week ending Sept. 30 the output of the combined producing associations showed a decrease accompanied by a marked drop in shipments and orders. Shipments from the southern pine field have been the most hampered of any of the sections, being the lowest since the first of the year. On the West Coast the car situation is not so serious as in the South; the production is still well up and the mills are endeavoring to catch up with earlier delays due to forest fires. Prices same as reported last week.